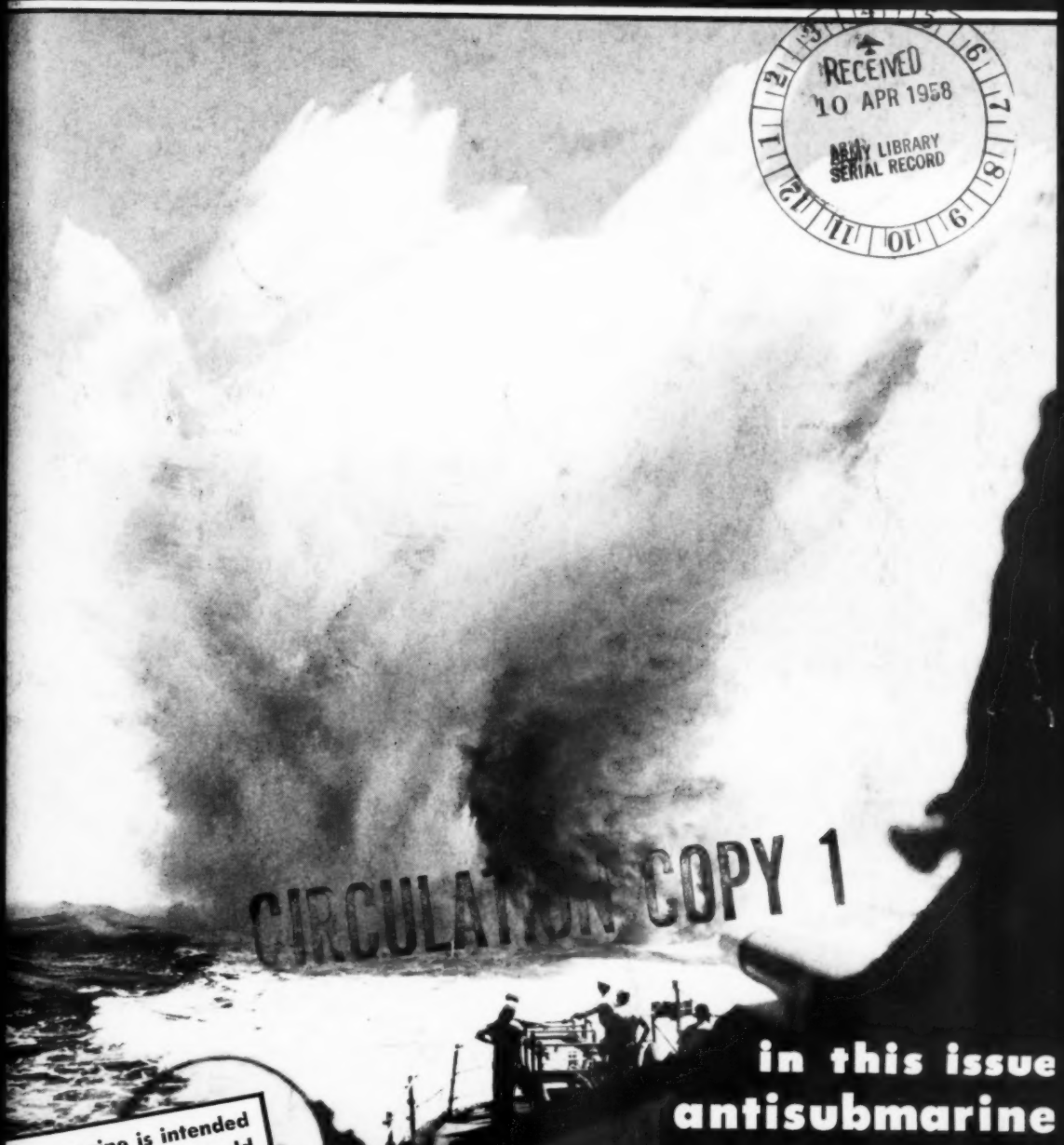
ALL HANDS



in this issue
antisubmarine
warfare

APRIL 1958

ALL HANDS

THE BUREAU OF NAVAL PERSONNEL INFORMATION BULLETIN

APRIL 1958 Nav-Pers-O NUMBER 495

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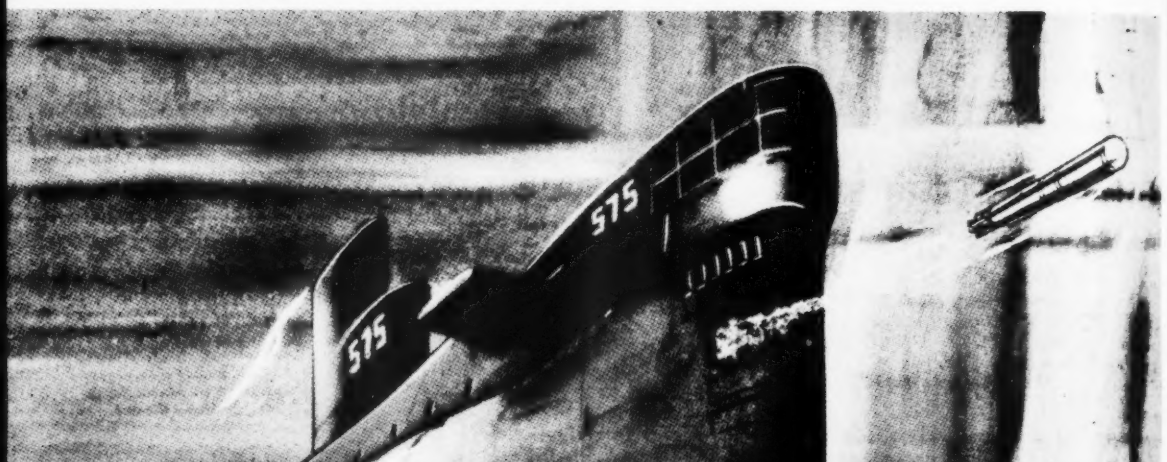
• **FRONT COVER: SPRAY OF DEATH** — Tons of water blow skyward from depth charge explosion at five fathoms astern of Pacific Fleet hunter-killer escort destroyer *USS Philip* (DDE 498) during DesRon 25 training exercises off Hawaii.

• **AT LEFT: THEY ALSO SERVE** who sweat it out below. Crew in forward torpedo room of USS *Dogfish* (SS 350) find that waiting at full submergence is hardest part of their duty as they listen to hunter-killer group above probe the seas for their location.

• **CREDITS:** All photographs published in ALL HANDS are official Department of Defense Photos unless otherwise designated. Photo on page 53 by New York Times.



THIS IS ANTISUBMARINE WAR

FLASH . . . . . OPERATIONAL PRIORITY . . . . . 12 UNIDENTIFIED SUBS SIGHTED X LAT 69-43-01 N LONG 6-17-12 W X BELIEVED TO BE LONG RANGE ZULU TYPE WITH MISSILE HANGARS AND LAUNCHING RAMPS AFT X SUBS TOOK EVASIVE ACTION WHEN APPROACHED X MAINTAINING CONTACT X SITUATION REPORT FOLLOWS"

Sound far-fetched? It's not. A dispatch such as this from a unit of an Advance Early Warning Barrier *could* be the tip-off to a sneak attack.

It's the Navy's job to prevent enemy submarines from launching a surprise attack at our shores. To do this, the Navy must build-up and maintain a strong offensive, as well as defensive, force to combat any potential submarine menace which might present a threat to this country.

Although the above message may be slightly exaggerated, similar messages reporting unidentified isolated submarine contacts are made quite frequently—even more so than the average person realizes.

When a single unidentified submarine contact is reported, certain designated Fleet units are immediately dispatched to keep a watchful eye on the prowling submarine.

But if a group of them in a mass movement—such as in the above example—were sighted, things would move fast. The Navy's widely dispersed, gigantic air-surface-underwater antisubmarine defense team would go into action in a matter of seconds. Within a given radius of the reported sightings, every available ASW unit would be called upon to search for, and to keep the unidentified subs under constant surveillance, and attempt to determine if their intent was hostile or friendly.

ANTISUBMARINE WARFARE is today one of the U. S. Navy's most important areas of responsibility for defense. Little difficulty is anticipated in maintaining superiority over enemy surface vessels in the time of war, but the dangers from enemy submarines is something else. According to the Chief of Naval Operations, the threat from enemy submarines is "grave." And the job of combating this threat, Admiral Arleigh Burke, USN, said, is the "most difficult technical problem which confronts the U. S. Navy."

Twice within recent memory U-boats have almost cut off the flow of supplies to our troops and allies overseas. If we should be faced with that problem again it would be on a much larger scale, and in both the Atlantic and Pacific Oceans.

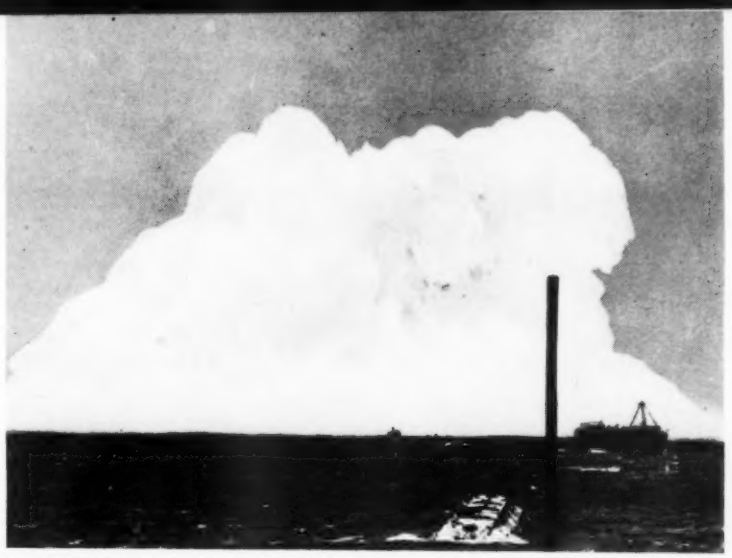
Not only do submarines represent a threat to halt traffic on the world's sea lanes, but—with the ability to launch guided missile attacks—they are also a danger to both coastal and inland cities. This is one of the greatest threats confronting any nation in a modern type of war.

Since the U. S. Navy has succeeded in uniting the guided missile and the submarine, it stands to reason that other navies are also capable of doing the same thing. At this time, however, there's not much chance of enemy submarines launching a large-scale guided missile attack against our shores. Large numbers of conventional powered subs are not likely to make the long trek across the Atlantic or Pacific without detection. In order to operate submerged, conventional submarines must expose their snorkel tubes to run their diesel engines or to charge their batteries again.

Up until the present day, antisubmarine warfare was based on one premise: that the submerged (conventional) submarine is powered by a storage battery that will exhaust itself very quickly at high speeds or in a matter of hours at very low speeds.

Once a sub sticks up its snorkel tube—and exposes itself—it's in real danger. Highly improved radar, now in use by our advance early warning units, would pick up the snorkeling submarine on its long, slow journey across the ocean.

TODAY, HOWEVER, the picture is radically different. Destroy the old premise, as nuclear power has done,



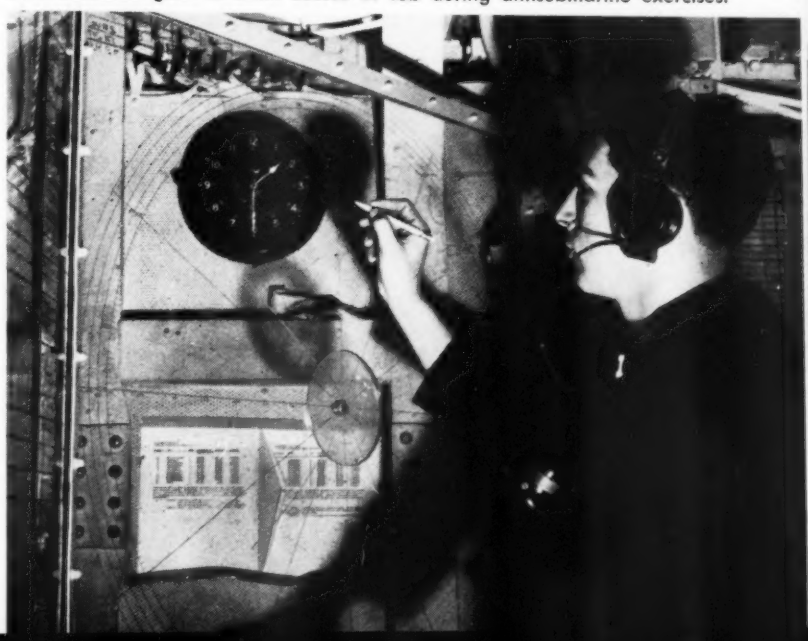
BIG BLOW—Pictured here is the firing of an underwater nuclear device. Navy now has the atomic depth charge *Betty* which has a large lethal range.

designed, equipped, trained and capable of combating any conventional submarine threat which may confront us. Our ASW forces are second to none. According to Admiral Burke we can now defeat an opposing conventional powered submarine force. This job would, however, be no pushover. It can be done only as a coordinated team effort between our long-range patrol planes, destroyers, submarines, blimps and antisubmarine support carriers with their helicopters and ASW planes.

BUT IF AN ENEMY'S submarine fleet was made of a large number of atomic boats, the situation would be radically different. Our existing forces are not capable of stopping a large number of nuclear submarines. This reality presents a tremendous problem to our air, surface and sub-surface antisubmarine forces.

It must be remembered that as progress in submarining continues, it is essential that our antisubmarine forces also make strides forward to meet this progress with counter advances. The ASW game is a grim one and the Navy is continually seeking new ideas and concepts to combat high speed nuclear subs.

TRACK DOWN—Members of CIC in a destroyer compile information received over detection gear to chart course of sub during antisubmarine exercises.



NWARFARE

and the matter of hunting and knocking out submarines becomes much more difficult.

So fas as nuclear submarines go, the U. S. Navy is way out in front. We now have three in operation and the fourth is nearing completion. Fifteen more are being built or have already been authorized, and eight more are called for under next year's (fiscal '59) shipbuilding program. By 1960, we should have at least 20 nuclear submarines in operation.

To the best of our knowledge, no other nation possesses nuclear-powered submarines. But we cannot expect to hold our monopoly on them forever. There's a possibility that by the time you read this, or shortly thereafter, you'll be hearing about atomic-powered submarines joining other fleets. Whenever they do, the job of maintaining control of the seas will be somewhat different from what it is today.

Our ships and planes of today are

SCOUTS OUT—S2F *Trackers* of Air Antisubmarine Squadron 37 fly over their mother carrier *USS Philippine Sea* (CVS 47) during Seventh Fleet operations.

Taking advantage of knowledge gained through extensive operations of our own nuclear subs, the Navy has launched an all-out concentrated effort to come up with new means to detect and kill atomic submarines. This effort is centered around a stepped-up research and development program in which a major antisubmarine "break-through" is needed. The Navy is determined that it must soon achieve such a breakthrough which will result in much greater detection ranges and faster, long-range underwater weapons which can overtake and destroy fast-sailing nuclear submarines wherever they may be encountered.

As a part of this effort, submarine designers have come up with what they term a radically new submarine killer. This weapon is currently under construction and is expected to join the Fleet in 1960. Theoretically, it will be an exceptionally *high-speed nuclear-powered antisubmarine submarine equipped with long-range sounding devices and armed with sub-surface atomic missiles.*

Today's Navymen, however, are not placing confidence on any single "infallible" method for outsmarting enemy submarines, but are putting into practice new tactics and strategy. These wide-range ASW concepts were developed by combining experience and abilities, through the exchange of ideas, imaginative planning and forthright recommendations from veteran submariners and ASW personnel. (The Navymen working in ASW are the guts of the whole program—they know its importance.)

As a result, almost every combatant ship, plane and weapon the Navy has in operation today, being built or under development, is designed to play some part in antisubmarine warfare.

THE NAVY'S COMMAND STRUCTURE and personnel training, as well as ships, planes and weapons, are also geared for ASW. This is essential because of the many different bureaus, research and training activities, and Fleet units which must work hand-in-hand to form an effective ASW team.

As an example of the Navy's command structure being geared for ASW, take the recently established billet for an Antisubmarine Warfare Readiness Executive on the staff of the Chief of Naval Operations; and the Atlantic Fleet's new Antisubmarine Defense Force.

ASW Readiness Executive

Rear Admiral Charles E. Weakley, USN, a veteran of the Battle of the Atlantic and post-war leader in the development of new weapons and tactics against submarines, has been named to fill the newly created ASW post on Admiral Burke's staff.

It's the job of RADM Weakley to review—at all levels of command—the Navy's entire ASW effort and determine its adequacy. With a small, hand-picked staff of experts, he will be charged with speeding up the wide-spread ASW program and seeing that it is carried out.

Underseas Warfare Branch

The reorganization of the Navy's high level command structure takes coordination of over-all antisubmarine warfare from the Director of Underseas Warfare and puts it directly under the Chief of Naval Operations. RADM Weakley formerly headed the Underseas Warfare Branch in the Office of the Chief of Naval Operations. He was relieved of that position in January by RADM Lawrence R. Daspit, USN, who is now responsible for the direction of undersea warfare including mines, mine countermeasures and harbor defense.

HOMING 'PIGEON'—One of Navy's acoustic homing torpedoes heads for target. It can be merely thrown over the side. For more recent model see p. 30.

Antisubmarine Defense Force

The Atlantic Fleet's Antisubmarine Defense Force has been in full-swing for almost a year. It's headed by Vice Admiral Frank Watkins, USN, who has the centralized authority for all antisubmarine efforts in the Atlantic Ocean area. To carry out this task VADM Watkins has two separate operational commands under his control. They are the Hunter-Killer Force (HUKFOR) and the Submarine Killer Force (SUBKILLFOR).

Hunter-Killer Force

The Hunter-Killer Force coordinates the efforts of the aircraft carrier antisubmarine groups and performs many of the duties of the former Antisubmarine Command from which the new ASDEFOR grew. There are four antisubmarine carrier divisions in the Atlantic Fleet assigned to this HUKFOR. (The Pacific Fleet, does not have a separate antisubmarine command but-equally prepared to meet any potential submarine threat—it also has two ASW carrier divisions.)

Submarine Killer Force

SUBKILLFOR, which consists solely of Atlantic Fleet submarines capable of seeking out and destroying enemy submarines, is commanded by RADM F. B. Warder, USN, Commander Submarine Force, U. S. Atlantic Fleet. He formerly headed the Underseas Warfare Branch.

ASDEFORLANT is the first command of its kind. There's no other quite like it. It was established in June 1957 in an effort to provide better defense against enemy submarines as well as certain other responsibilities in connection with the Fleet's mission of defending the U.S. from attack through the Atlantic Ocean Area. This includes the Atlantic Barrier Command—the dual-purpose seaward extension into the Atlantic of the continental early warning radar lines by electronic-packed ships and aircraft. (See the September 1956 issue of ALL HANDS.)

The Antisubmarine Defense Force is not a conventional type command such as COMSUBLANT or COMDESLANT. It is an inter-type command. Its operational units include ASW support carriers, destroyer type ships (DDs, DLs, DDEs, DEs and DERs), various types of submarines, ocean radar station ships, land-based patrol planes, blimps, helicopters and carrier-based planes.

CARRIER-BASED whirly birds with special detection gear play important role in ASW. Here, copter takes off from *USS Essex* (CVS 9) during NATO maneuvers.

With such a wide variety of ships and planes, you can see that the art of antisubmarine warfare is a highly complex business. In addition to the ships and planes, the over-all ASW system is built around the many different types of electronic detection devices which they carry.

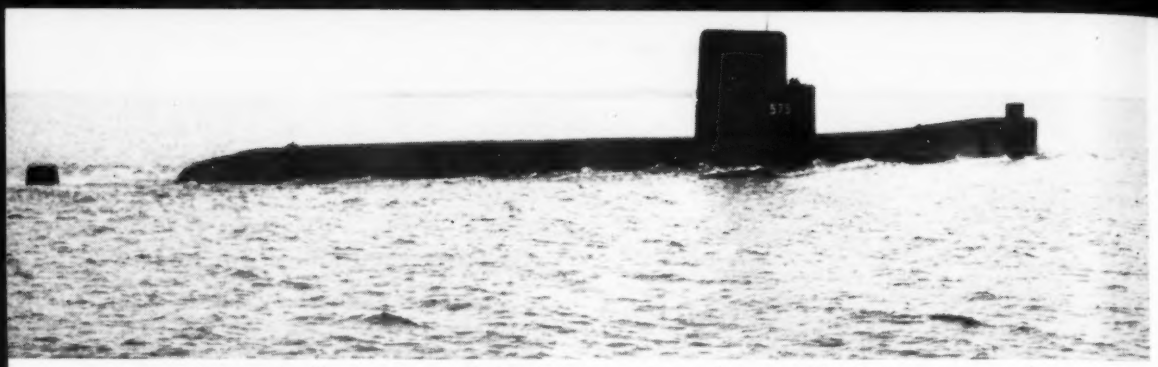
SONAR—both active and passive—is, without a doubt, our number one method for detecting a submerged submarine. Great strides in both accuracy and distance have been made in underwater sound detection in the past decade. Ranges of active sonar in operation today are more than six times greater than they were in World War II. Advances in passive sonar, which is used largely and most effectively in submarines, are even more impressive. They are, however, far from being sufficient.

In addition to the sonar installed aboard ships, blimps and helicopters carry "dunking sonar" or a sonar ball. This consists of listening gear lowered into the water on lines hanging below the low-flying craft. This has an advantage over shipboard sonar because it is not affected by self-noise.

Highly improved sonarbuoys are also used extensively. They are dropped from the air and broadcast the noise of submerged subs to hovering aircraft or ships in the area. (See page 36 for more details on underwater sound.)

Other than sonar, there are five additional methods for detecting submarines at sea. They include: *radar, radio-direction finding* (RDF), *magnetic air-borne detectors* (MAD), *electronic countermeasures* (ECM), as well as by *sight or visual observations.*

AS IMPRESSIVE AS these detection devices may sound, sonar and MAD gear are the only ones which can be used against completely submerged submarines. All other methods of detection are useful only if the submarine is surfaced, operating on snorkel, or cruising at periscope depth with its scopes or antennas projecting above the surface. RDF is useful only when a submarine is using its radio, and ECM is useful only so long as a sub uses its radar;



ATOMIC-POWERED subs like *USS Seawolf*, SS(N) 575, are fast and evasive. They have put new emphasis on ASW.

then by reading the radar "pulse" the sub's approximate location can be fixed.

Even with all the complex detection gear in operation today, the big danger is that the presence of submerged enemy submarines will not be known until they attack. This is because the effective range of existing antisubmarine detection devices is much shorter than the effective attack range of a submarine.

Once a sub launches its attack—whether it's a torpedo attack against a single ship or a number of ships in a convoy, or even a guided missile attack against shore installations—its position is revealed. Then the attacking sub's future may be harried and brief. But we don't want to find ourselves in a position where we have to detect a submerged sub only after it attacks. The ideal situation is to detect and destroy it before it has an opportunity to strike. And that is just what VADM Watkins' Antisubmarine Defense Force is set up to do.

ONCE AN ENEMY SUBMARINE is located, the job of killing it, with our modern weapons, is relatively easy. The weapons used for the "kill" in ASW have made more rapid progress in recent years than hunting or detection equipment.

One of the most recent additions to the Navy's operational ASW arsenal is *Betty*. Although not a lady, she's more than enough to make any sailor raise an eyebrow and give a whistle. *Betty* is an atomic depth bomb designed to be dropped from an airplane.

As for atomic weapons in antisubmarine warfare, VADM Watkins tends to modify the popular belief that such weapons would dominate operational planning. The capability of scoring hits is the key to ASW success, he said. "You don't have to smash a sub to kill it, just a small hole can do the job," he pointed out. Of course atomic weapons eliminate the necessity of direct hits by increasing the area of destructive force, but if you can find a sub and then hit it, conventional weapons are equally effective. (It has been announced that *Betty* is capable of killing enemy subs within miles from the point of explosion rather than in feet—the range of conventional depth charges.)

Supplementing our atomic ASW weapons are: new types of acoustic and magnetic homing torpedoes that move in a spiral pattern as they seek out their target; highly improved, rapid-sinking depth charges; hedgehogs—rockets that are fired in a pattern to cover a wide expanse of the ocean; and Weapon Able, a powerful rocket-propelled depth charge.

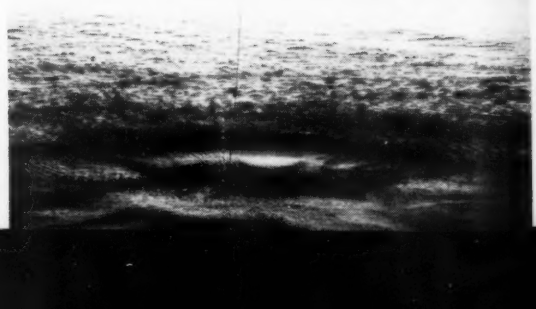
OTHER THAN THE NEW atomic weapons, the new type homing torpedoes . . . now in operational use throughout the Fleet . . . are among this country's most promising ASW weapons. Termed as the "knock-out punch" needed to pursue and destroy submerged subs, these antisubmarine torpedoes are regarded as a highly significant step forward in the see-saw battle over the years between submarines and the weapons to counter them.

These target-seeking torpedoes can be fired from almost every type of ship and plane. When available in quantity, they will most likely replace conventional depth charges, hedgehogs and other antisub weapons. They are built in a variety of sizes and types and can be used effectively by land-based patrol planes, smaller carrier-based aircraft, helicopters, blimps, destroyers, patrol vessels, and submarines.

Anticipating that enemy submarines will employ decoys to attract the homing torpedoes from their target, these ASW torpedoes have built-in "brains" which distinguish noisemakers from the real thing.

These are but a few of the many weapons and means of detection available for antisubmarine warfare.

SUB SPECIALISTS — S2F patrol planes and special copters with sonar balls form drag net for catching subs.



But how they are utilized is the important factor. In the event of an attack, ships and planes equipped with these weapons and devices would be deployed to combat enemy submarines in three phases. (See illustrations appearing on pages 31-34.)

- *First* — Destroy enemy submarines before they get to sea.
- *Second* — Seek out and destroy enemy submarines en route to the target.
- *Third* — Destroy enemy submarines after they arrive in the target area.

IN THE EARLY PHASES fast attack carrier striking forces strike at the very sources of the enemy's submarine power. This includes the submarine bases, training, supply and support facilities, and shipbuilding yards. These striking forces are made up of attack carriers with their interceptor and attack aircraft; cruisers, both conventional and guided missile classes; all types of destroyers; conventional, nuclear-powered, hunter-killer and guided missile submarines; and long-range seaplanes. These units are supported by antisubmarine carrier groups and land-based aircraft. (Just imagine how different the Battle of the Atlantic would have been IF the U.S. Navy had had the capability of knocking out the German submarines at source early in World War II.)

Our own submarines will be used in antisubmarine tasks off enemy bases and in barriers across enemy submarine transit paths, to lay mines and attack enemy installations with guided and ballistic missiles, as well as in their familiar role of attacking enemy shipping.

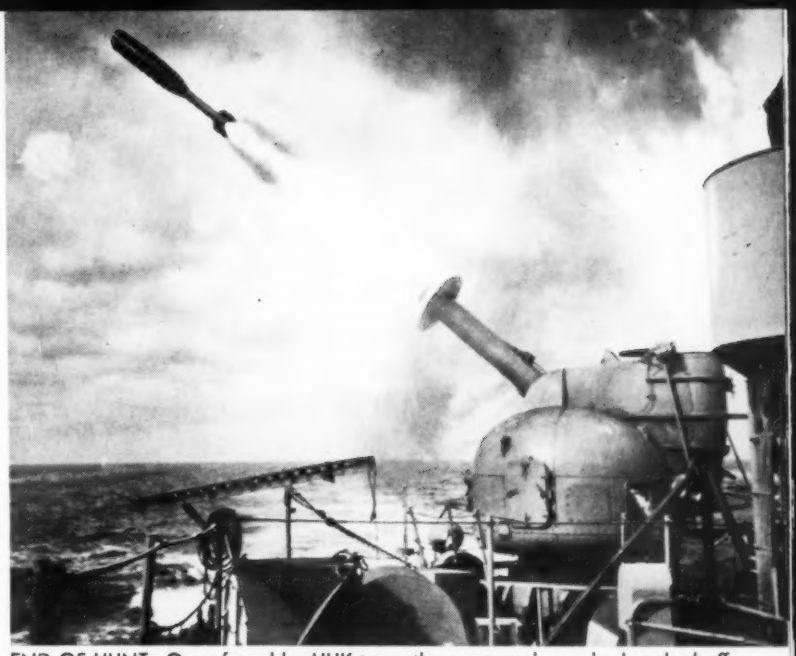
OUR HUNTER-KILLER antisubmarine carrier groups are versatile packages of great offensive antisubmarine power. In addition to supporting our combatant forces and convoys, they are used to "sanitize" strategic areas such as in barriers across enemy submarine transit paths or off the approaches to the coasts of the continental U.S. (See page 24 for more details on hunter-killer antisubmarine group operations). Submarines, frigates, destroyers, destroyer escorts, and all types of antisubmarine aircraft (carrier-based fixed wing planes and helicopters and blimps as well as land and sea patrol aircraft), are available to operate with the antisubmarine carriers in hunter-killer tasks, if needed.

And then we'll have our long-range patrol aircraft in surveillance over large ocean areas, together with our many destroyers to protect the vital merchant shipping upon which our industrial might and our overseas forces depend.

The effectiveness of all this ASW strategy is, of course, dependent on the use of submarines, ships and aircraft—with their detection and destruction weapons—through *team effort*. By combining the stealthy submarine to detect, with the rapid weapon delivery capabilities of the aircraft, or the relentless search capabilities of destroyers, blimps and other patrol aircraft, the U.S. Navy has at its disposal an ASW system second to none.

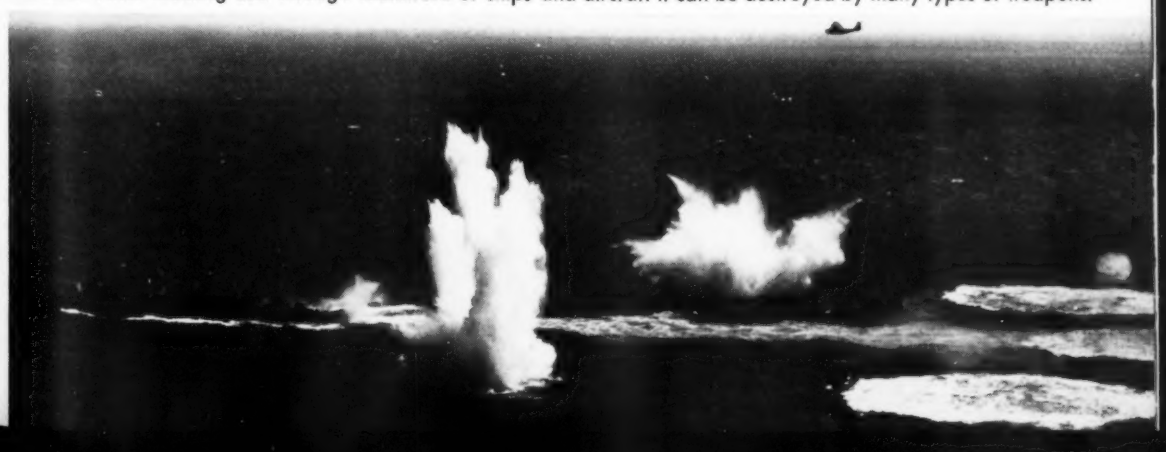
And the brains of that ASW system is the Navyman. Navy crews in submarines, ships and aircraft make this team work. As stated before, they are the whole guts of the vital ASW program.

—H. George Baker, JOC, USN.



END OF HUNT—Once found by HUK team the enemy sub can be knocked off by one of many ASW weapons. Here, DDE fires at target with Weapon Able.

THE KILL—After locating sub through teamwork of ships and aircraft it can be destroyed by many types of weapons.



early on the morning of 14 May 1944. A group of destroyers sped to the scene. After a series of contacts, depth-charge attacks and searches—which lasted 72 hours—*U-616* was damaged enough to force her to surface. The crew abandoned her amid a bombardment by the sea-going gun platforms. The submarine sank. Three minutes later there was a heavy submarine explosion and large bubbles of air came to the surface. (See Feb 1957 issue of ALL HANDS, pp. 60-62.)

BEFORE AND AFTER the attack on Pearl Harbor, undersea warfare was a dominant theme, both in and out of the destroyer forces.

As in World War I, four-stackers made history in their fight to protect vital convoys against undersea craft. But newer destroyers and other destroyer-type ships were being built and launched to take their share of the responsible task of getting slow six-knot convoys through mountainous sub-infested North Atlantic seas to destinations in England, Ireland, Murmansk, and the long sea lane route in the Pacific.

Destroyers Make Good Sub Cat

EVER SINCE THE REVOLUTIONARY WAR when, in 1776, David Bushnell's submarine *Turtle* caused a fine state of hysteria by making a submerged attack on a British warship in New York harbor, man has tried to find ways and means to detect and destroy the undersea menace—the submarine.

The menace was felt in the Civil War (see page 42) and it grew to large proportions in World War I. Before the entry of U.S. forces, England was on the verge of starvation. The U-boat blockade had all but won the war. That blockade was smashed when American destroyers ran interference for convoys.

In 1934 the U-boat became the core of the new German navy. Five years later — within a matter of hours after Great Britain and France declared war—one of these U-boats torpedoed the British liner *Athenia*. Before the European fighting ended, 2770 Allied and neutral ships totaling 14,500,000 tons were sunk after being hit by torpedoes.

A 3000-pound torpedo is only 21 feet long. But it contains 400 to 600 pounds of high explosive in its warhead and is a powerful weapon when propelled by steam or electricity. The steam-driven variety has the disadvantage of leaving a tell-tale wake to warn the ship of its approach. The electrically propelled torpedo does not. Many a seaman has watched torpedo tracks cleave a path to his ship; others never knew what hit them.

But a torpedo alone, like a bullet without a gun to fire it, is nothing. If you can get the submarine *before* it fires its torpedo, you and the convoy are safe.

MANY SEGMENTS of the Navy are geared to fight against submarine attacks. A big part of the job has been handed to destroyer-type ships. Why? Here are four good reasons — and there are probably more.

- All weather capability — Destroyers can remain in the area of "contact" in any kind of weather.
- Staying power—They can remain with a contact for days or weeks at a time.
- Versatility—They can be the protecting bulwark of a task force or a convoy.
- Weight-carrying capacity — They are the only antisubmarine weapon that can carry all of the weapons and systems necessary to conduct a complete attack on a submarine.

One of the many instances of the remarkable ability of destroyers, working as a team under wartime conditions, will illustrate some of these reasons:

U-616 had torpedoed two merchant vessels traveling in a convoy

In the Pacific, destroyers employed the same tactics and used one of the major ASW devices which helped drive the U-boat out of the Atlantic—this device was the hedgehog, which threw a pattern of depth charges with each salvo. The hedgehog depth charge was much smaller than the standard "ash can" or "tear drop" but the salvo, which covered a wide area, had an effect similar to shotgun fire.

Operating in May 1944, the destroyer escort USS *England* (DE-635), in teamwork with *George* (DE 697), *Raby* (DE 698) and *Spangler* (DE 696), put on a performance that bid fair to hedgehog the Japanese submarine force out of existence. On a rampage in the Solomons, *England* destroyed six Japanese submarine in 11 days—a feat that broke two world records.

Locating the sub

Then, as today, the first problem in antisubmarine warfare lay in the the field of detection. To kill a submarine you must first find him. Furthermore, it is helpful to find him before he finds you.

TOMORROW'S DD (artist's conception) will be better equipped for ASW.

Sub Catchers

To find submarines, each destroyer-type ship has a sonar room (see page 39) which is not much bigger than an average walk-in closet. To get an idea of what makes up and what goes on in a typical sonar room, let's go aboard uss *Caperton* (DD 650), one of the first ships ever to be awarded an "E" in ASW.

In this room a maze of instruments and gadgets occupies most of the available space. The remainder of the space in the room is taken up by five men—the operators of these instruments and gadgets. As lights flash and motors hum, there is the "ping" sound (actually it isn't a ping at all but is more like the sound of a hammer striking a sharp blow on an anvil).

Each of these five men has a definite job. There is no room for individualism. All, working as a team, have one purpose in mind—get that sub.

The sonar operator calls out the ranges and bearings to the contact appearing visually on the sonar scope. As the sound goes out, he watches it appear on the scope as a pattern similar to that formed by a stone tossed into a mirror-like lake which causes ring-like ripples to come out in widening circles.

The firing petty officer, manning a phone circuit, is in constant communication with the hedgehog mounts. Another man takes care of the depth finder. There must be room for the conning officer who receives and collates all the information and makes the attack. The range recorder operator (in many cases, he is the conning officer) completes the group working in the sonar room.

But the men, machines and gadgets in the sonar room only form one link in the chain which goes to make up a successful run on a submarine. The remainder of the chain is made up of other destroyermen and more machinery in CIC and on the bridge, the engine and fire rooms. It includes the hedgehog operators, the torpedoman's mates, lookouts and many more.

The Attack

The contact made by *Caperton* is classified as a submarine. The surface bearing is clear, and "bridge" gives the order "Make the Attack!"

Here is where hours and hours of training pays off—one way or the other.

The phones are manned, connecting CIC, JOOD and Sonar. Another set of phones keeps the hedgehog operators informed. Information starts to flow, slowly at first, but speeds up as ranges decrease.

CIC commences to plot. Ranges, bearings and other pertinent data

DEATH BELOW—Conventional depth charge explodes off stern of destroyer during Atlantic Fleet training exercises.

GETTING LOADED—Destroyermen load antisub weapons. *Left:* Hedgehog and (right) torpedo are made ready.

are grease-penciled in on a visual board in the bridge. As the tension builds, the voice of the sonar operator cuts in with, "I hear an increase in the screw beat." CIC comes in on another circuit with, "I have him in a right turn."

It isn't long before sonar reports a high doppler (the pitch of the echo goes up). At almost the same time, CIC reports that the submarine, according to their plotting, is coming toward the ship.

The constant flow of information comes to the conning officer in bits and snatches and the pieces come together like a giant jigsaw puzzle. Information is relayed to the JOOD who constantly gives the course changes to the steersman. The man at the wheel brings the ship to the attack heading.

Shortly before the final run, the hedgehog operators report. Their equipment is ready; they are behind the flash shield. At precisely the right moment, the firing petty officer fires the hedgehogs. If the men, machines and gadgets have worked as a team, a "kill" may be recorded.

LINE UP of sleek greyhounds lead by *USS John S. McCain* (DL 3) would be plenty of trouble for enemy sub.

Two-ship Attack

In a two-ship attack, twice as much information is recorded—your own and that of your sister ship. During these runs, training, skill and insight — not hindsight — are your requirements.

Information is literally poured out, for—whether you are the attacking ship or the assisting ship—you must not only track your own ship and the submarine preparatory to making the attack, but you must also keep track of your opposite number. In addition you have to keep seniors, such as a HUK commander, informed of what you are doing.

Caperton goes through with its run, notifying the assist ship, in this case *Dashiell* (DD 659), when it has been completed. The captain makes sure that he does not leave an echo-creating wake in the path of the stand-by ship now moving in for his attack. In a fast changeover *Dashiell* becomes the attacking ship and pounces on the submerged victim.

The attacking ships repeat this process until there is no longer a submarine to contend with.

The coordination and cooperation required in these high-speed close maneuvers is so close that each commanding officer has to know what the other is going to do at all times. Imagine, for example, that you are making an attack with a destroyer, moving at 20 knots. Your destroyer is on one side of the submarine, some 1500 yards away. The attacking destroyer starts toward you, fires its hedgehogs and the gap closes. Wouldn't it be to your advantage to have an inkling of just which direction that other destroyer is going to turn?

Without constant inter-ship coordination, delays would result—and even a slight delay might mean you've lost your submarine contact.

THE JOB of insuring that convoy escorts are ready to meet the challenge of the increasingly potent underseas threat cannot be overestimated.

Over 2500 merchant ships, at sea each day, support our allies throughout the world in peacetime. If a war came, these merchant ships would have to be protected. As in World War II, sailing them in convoys

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SEARCH

would be a proven way to insure that American land, air and naval forces overseas, as well as those of our allies, would be supplied with the necessary weapons and products of American industry. Conversely, it would be our only way to insure that our industry would have the raw materials it needed.

At the center of the convoy team is the destroyer and the smaller destroyer escort whose sonar gear revealed the enemy subs and whose depth charges and hedgehogs sank the marauders during World War II.

Most of the destroyer-type ships now have the longer range sonar and the newer fire control gear than you might remember. Destroyers are getting sonar ranges now that are greater than those achieved during the Korean conflict and those of WW II.

Furthermore, more modern automatic tracking systems give the destroyer much better kill capabilities than were obtained during the past war. However, all these new mechanical improvements have pointed up one thing. Operator performance and team performance are of even greater importance.

The addition of helicopters to USS *Mitscher* (DL 2), *Norfolk* (DL 1) and *John Paul Jones* (DD 932) has increased the "kill" possibilities of these greyhounds. An offensive weapon, the helicopter is armed with torpedoes and is vectored to the submarine by the destroyer holding the contact. While the destroyer holds this contact and keeps out of range of the submarine's torpedoes, the helicopter hovers over the victim, drops one of its homing torpedoes and returns to the destroyer after the kill.

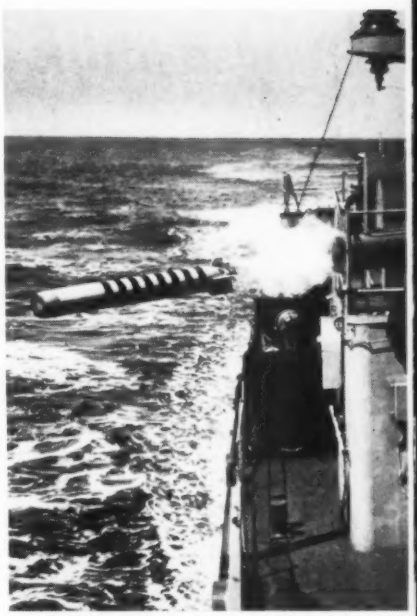
Should this method miss, there is *Weapon A*, a destructive missile charge with TNT in it which can be hurled a considerable range. Another weapon is the hedgehog. These depth charges are mounted on a rack and can be fired ahead of the ship or on an angle, singly or in pairs, sending them off in a string-of-firecrackers style. These land in a pattern, which has the same effect as a shotgun blast. Homing torpedoes and conventional depth charges are the two remaining weapons of the destroyer-type ships. If all fail, they can try the method used during WW II by the four-stack destroyer USS *Borie*—RAM!

WHAT DOES THE FUTURE hold so far as antisubmarine warfare goes? The men who ride destroyer-type ships are never satisfied. They hope for sonar gear that will pick up submarines at greater distances, and weapons that will kill submarines at these ranges. In the meantime, they'll go right on in their business of training for any possible war of the future against all types of submarines.

ComDesLant sums up the role of the destroyer:

"She is the prime submarine hunter-killer. She guards convoys and screens the flattops. The radar picket destroyer is an integral part of the Distant Early Warning Line. Her complex radar and sonar gear makes her the bloodhound of the seas. Her five-inch guns can bombard enemy shore positions, and her light draft makes it possible for her to guard minesweepers close inshore. Missiles have made her even more potent. There seems to be no limit to the capabilities of the modern destroyer. The destroyer's armament and efficiency make it clear that the U. S. Navy is ever ready in defense of the free world."

—Thomas Wholey, JOC, USN.



THE TORPEDO has been a powerful weapon of destroyers since WW I. Here, latest homing type is launched.

SEARCH—DDs and blimp practice ASW. *Rt:* Navymen keep watch in sonar room of *USS Hugh Purvis* (DD 709).

These Ships Are the Workhorses of ASW

Some of the "workhorses" of the Fleet which have the primary mission of keeping the sea lanes clear of potential enemy submarines are listed here. Taking them by class, one at a time, they include:

• ***Gearing-Sumner class*** — This late WW II vintage general purpose destroyer is 390 feet long, and weighs 2340 tons. *Sumner* destroyers are 16 feet shorter. Both are armed with three twin-barrelled, five-inch dual purpose gun mounts plus several rapid fire three-inch antiaircraft guns and two hedgehog mounts, depth charges and antisurface ship and antisubmarine torpedoes. These ships are very maneuverable and have a speed of over 30 knots.

• ***Lavallette class***—These general purpose destroyers, called *Fletcher* class in WW II, weigh in at 2100 tons, are 376 feet long with a 34 knot speed. This extremely maneuverable class ship was the backbone of Pacific seapower in early WW II years. It carries four or five five-inch dual purpose guns, several three-inch rapid fire AA guns or 40mm mounts, hedgehogs, antisurface and antisubmarine torpedoes and depth charges.

• ***Forrest Sherman class***—A general purpose destroyer. Its prototype, USS *Forest Sherman* (DD 931), which was commissioned in 1955, is the first general purpose destroyer built since WW II. With a speed of over 30 knots, this 418-foot, 2650-ton DD is armed with one automatic rapid fire five-inch dual purpose gun mount forward; has two aft. Several automatic three-inch antiaircraft guns, antisurface and antisubmarine torpedoes, hedgehogs, depth charges, long-range radar and sonar equipment, large CIC and large ASW and gunnery plot rooms also go into the offensive and defensive makeup of this class ship.

• ***Guided Missile Destroyer***—USS *Gyatt* (DDG 1), a *Gearing* class ship, became the world's first guided missile destroyer when recommissioned in Dec 1956. She has a twin-missile launcher on her fantail and a horizontal automatic loading and *Terrier* missile stowage compartment in the after section of her superstructure.

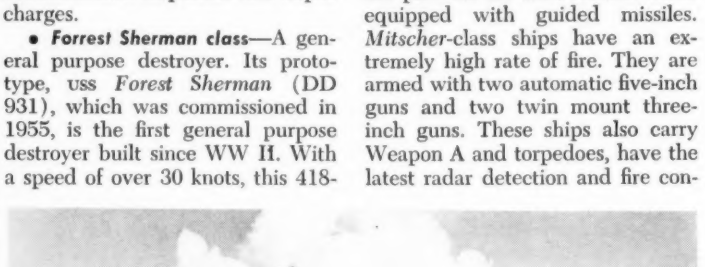
• ***Mitscher class frigate*** — Formerly called destroyer leaders, these large sleek ships, the size of WW II light cruisers, weigh 3650 tons and are 439 feet long. They are extremely fast, maneuverable and seaworthy. USS *Mitscher* (DL 2), when commissioned in 1954, became the first postwar destroyer-type ship constructed. More are planned for construction to be equipped with guided missiles. *Mitscher*-class ships have an extremely high rate of fire. They are armed with two automatic five-inch guns and two twin mount three-inch guns. These ships also carry Weapon A and torpedoes, have the latest radar detection and fire control equipment, the most modern antisubmarine detection equipment and have large spaces for CIC, ASW and Gunnery plotting.

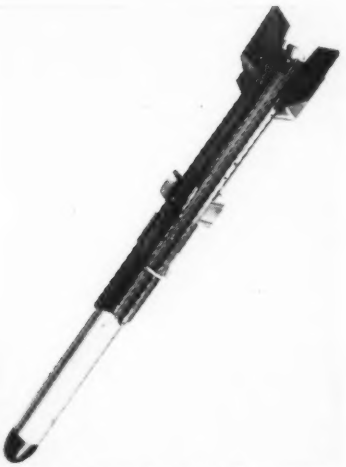
• ***Escort destroyers*** — There are two major classes of escort destroyers (DDEs); the converted *Gearing* and *Lavallette* class destroyers. In both classes, number two five-inch gun mount was removed and replaced by an advanced trainable hedgehog. Additional and most modern antisubmarine detection and plotting equipment was also installed. *Lavallette* class DDEs carry Weapon A (a rocket type antisubmarine weapon) instead of a number two five-inch mount. They have the most modern ASW equipment. Instead of five-inchers, DDE 825 class has a main battery of three-inch guns.

• ***Radar picket destroyers***—Converted near the end of WW II, the DDRs were general purpose *Gearing* class destroyers. They have additional long range air search radars and a larger CIC. Additional three-inch antiaircraft guns took the place of torpedo tubes. DDRs retain their antisubmarine capabilities.

• ***Escort vessels***—Hundreds of these were mass produced in WW II to escort convoys. Their primary mission is antisubmarine warfare. Displacing about 1200 tons, these ships are 306 feet long, very seaworthy and maneuverable but are slower than a destroyer. This is compensated for by the fact that they have longer endurance. They are armed with five-inch or three-inch guns (two mounts) plus hedgehogs, antisubmarine torpedoes and depth charges. Differing in armament and power plants, the DEs are divided into eight different classes.

• ***Radar picket escort vessel*** — In general these converted WW II diesel-driven destroyer escorts have the same mission as a radar picket destroyer—to serve as the eyes and ears of the Fleet. DERs have built-up sides to cover the main deck on both sides amidships. They also have a very large CIC, rapid fire three-inch guns and the newest air search radars as well as antisub detection and kill capabilities.





RAT BLASTS from deck of destroyer to strike submerged target miles away. *Rt: Rat* rocket 'sits' for portrait.

Brother Rat Joins the Navy

THERE'S A new type of RAT at large, and submariners would be well advised to dream up a somewhat different type of "rat guard" than may be found on every Navy ship when moored to pier or wharf.

The new RAT—which is a serious menace to every sub—is a rocket-fired torpedo officially designated as Rocket Thrown Torpedo Weapons System.

The RAT system with shipborne sonar can detect a submarine at long range, compute its course and speed, aim its launcher and fire a missile. The missile is fired into the air by a powerful rocket motor and is then lowered into the target area by parachute. Once in the water, it seeks out and intercepts the submarine by means of an intricate sounding device.

RAT can be fired from launchers installed on existing 5-inch twin gun mounts aboard various types of surface ships. A modification to search and fire control systems now in use permits them to fire it.

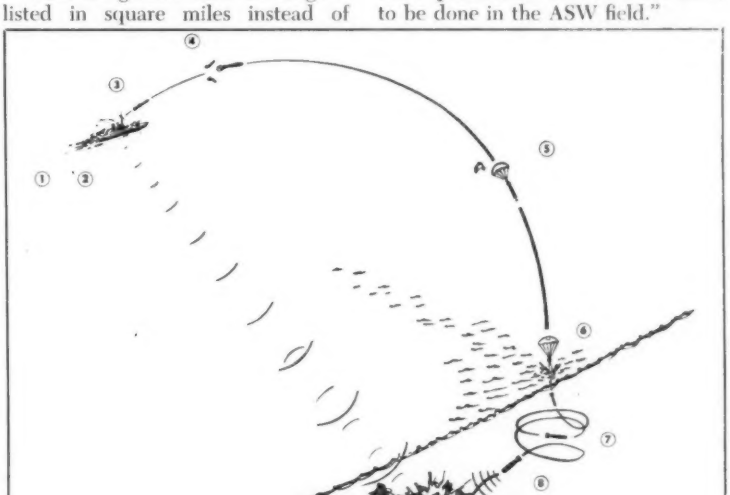
A ship's regular crew can operate the RAT system with a minimum amount of training. No additional personnel are required to operate or maintain the new antisubmarine weapons system which is now operational in both the Atlantic and Pacific.

When RAT was unveiled, CAPT William W. Hollister, USN, Commanding Officer of the U. S. Naval Ordnance Test Station at China Lake, Calif.—the activity which developed it—said, "This weapon is considered to be the greatest advancement to antisubmarine warfare since World War II."

RAT enables our surface ASW units to sink enemy subs without exposing themselves. They can attack a submarine without the sub knowing what is happening. Even if the sub does detect the rocket-launched torpedo homing in on it, it will be too late for it to escape.

With its greater area coverage—listed in square miles instead of yards—RAT-launching ships are capable of killing a submarine without leaving their screen, exposing the convoy they are guarding, or themselves.

Describing it as a fine weapon which provides great improvements to existing ASW capabilities, Dr. William B. McLean, civilian technical director of NOTS points out, that RAT is not the complete answer to ASW problems. "There's a lot more to be done in the ASW field."



1. Ship's sonar detects and tracks by signal
2. Fire-control system trains and elevates launcher, sets range
3. *Rat* is launched skyward
4. Airframe separates, first parachute opens
5. First parachute is released, second opens
6. *Rat* goes beneath surface
7. Torpedo begins search pattern
8. Torpedo pursues target by sound
9. Destroys target

Big Battle of the Future — SUB

A-POWERED SUBS can carry on ASW in all sea conditions. *Above:* Control room of *Nautilus*. *Rt: Seawolf* ups scope.

MORE THAN 300 FEET beneath the North Atlantic, USS *Nautilus*, SS(N) 571, unaware of the Sea State Five conditions on the surface, quietly moves through the water.

In a tiny compartment, no bigger than the average kitchen closet, John Smarz, ET2, USN, is busy at the complex sonar console.

Suddenly Smarz sits erect. The sub's delicate listening gear has picked up a suspicious sound many miles away. Slowly the noise gets louder and louder.

On the intercommunications system, Smarz calls the commanding officer. "Conn, sonar contact bearing three - zero - five. Estimated range 6000. Range closing. Contact bearing drift is right."

The skipper, CDR William R. Anderson, USN, acknowledges the report and orders, "Rig for quiet."

Nautilus' speed is reduced. Throughout the ship, refrigerators, record-players, heaters, soft-drink dispensers, blowers and other unnecessary equipment are shut off. Even talking by the crew is limited. Everything not essential to the boat's operation is stilled.

The contact gets louder and louder, and the sonarman continues to report new positions. CDR Anderson then asks, "What type contact do you believe it is, sonar?"

"High machinery noise level evaluated as snorkeling submarine, sir," is the reply from Smarz.

At this point, the commanding officer sounds general quarters and gives the order: "All hands man your battle stations, torpedoes . . . All hands man your battle stations, torpedoes."

Before the order is completed, the crew swings into action. Battle stations are not assigned to individuals because of their rate or rating. When it comes to GQ, the men are assigned to the jobs for which they are best qualified.

The sonar operator continues his evaluations: "Contact now bears three - zero - seven with range still closing." By now, CDR Anderson is preparing *Nautilus* for attack and is maneuvering her into position. Reports from sonar control continue:

"Contact now bears three - zero - one - zero." Taut seconds tick by and then, "Contact now bears three - one - one." Less than 25 seconds

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later, Smarz again reports, "Contact now bears three - one - nine."

At this point—using the data relayed from sonar control, as well as information provided from automatic computers — CDR Anderson has *Nautilus* in position and ready to make the kill.

The Conn Officer, meanwhile, has ordered the torpedo room to "Make tubes one, two and three ready to fire." When the homing "fish" are loaded and ready to fire, the torpedo room flashes the "ready-light" to conn.

Then, from conn, comes the order, "Open outer doors." When the outer doors to the torpedo tubes have been opened, the TMs flash the conn to that effect, and await further orders. When the bearing drift is correct, the long awaited order is given—"Final bearing—SHOOT!"

A button is pressed, *Nautilus* trembles and a dull reverberation comes from her bow—then another and another. Her torpedoes are off.

IF THIS HAD BEEN WAR, instead of a practice maneuver, the torpedoes would have been the real thing instead of a water slug or a dummy fish pre-set to pass under the "enemy" sub. If it were the real thing, there would be seconds of silence, a dull clank and then a rumbling explosion. The enemy sub would have been sunk and the men of its crew would never have known what hit them.

However, this was only an example of a routine training exercise —one of the many antisubmarine operations being carried out daily by units of the Atlantic and Pacific Fleet Submarine Forces. In this case, the "enemy" was one of our own conventional submarines.

The idea of using submarines in antisubmarine warfare is not new. Recently in a speech at New London, Conn., Admiral Thomas C. Hart, USN (Ret.), told a group of antisubmarine specialists that he had been sent to Europe in World War I with a division of subs so they could be used to combat German U-boats.

Although this evolution has been taking place for some time, it has been only in recent years that submarines opposing other submarines in underwater battles has been visualized.

Until *Nautilus*, a submarine has been an extremely elementary and restricted unit. It was nothing more than a highly versatile surface ship that was capable of submerging for limited periods. The primary means of power were dependent upon the atmosphere for combustion of fuels, and the small amount of power stored in a battery severely limited submerged speed and endurance.

WITH NAUTILUS, a revolutionary change in submarine operations was brought about. She's a true submarine and, with her nuclear reactor, is capable of operating submerged—completely independent of the atmosphere—for long periods.

USS Sargo, SS(N) 583

USS Skate, SS(N) 578

USS Nautilus, SS(N) 571

The ability to operate while submerged also unveils another capability of submarines that previously was denied because of the need to conserve its limited power. A nuclear submarine operating completely submerged avoids to a great measure the loss of power caused by bow waves, wind and sea conditions that are common to surface ships. These are some of the reasons why *Nautilus*, *Sea Wolf* and *Skate* are capable of running submerged comfortably and indefinitely at speeds greater than those of the majority of our present-day surface ships.

In addition to the almost unlimited submerged endurance and high speed which nuclear power contributes, it makes the submarine a true all-weather ship. It can navigate under the Arctic ice-pack.

With these high-speed versatile

USS NAUTILUS takes on torpedoes.

submarines, it is evident that the real threat of the submarine to surface ships lies ahead, and new counter-measures must be developed.

The submarine problem is twofold. Not only must the Navy be prepared to use the striking power of our own submarines through the perfection of weapons and techniques, but we must also be equally prepared to combat submarines in the hands of an enemy.

The execution of the ASW mission is an all Navy job—and the submarine is an important member of the team. For a long time the Navy has studied, practiced and used the offensive striking power of submarines, but mostly against surface ships and submarines on the surface or at periscope depth. This idea of hunting submerged submarines with other submarines has been considered for years, but the required technical capabilities were not fully available until *Nautilus*.

THE RADIATION OF SOUND waves through water is the submarine's main source of intelligence. Sound waves are curious and complex. Their speed and direction are influenced by water density which varies with its temperature, salinity and depth. Sound waves are also greatly influenced by the frequencies at which they are generated.

Normal noises in the sea are called ambient noises. The approach of another submarine can only be heard reliably when the ambient noise is less than that created by the approaching ship.

Self-noise—that is, the noise made by the ship which is listening—is the greatest deterrent to the detection of submerged subs. Since both the wave-slap of the sea on surface ships and the motion of the ship through the water create a great deal of self-noise, it becomes apparent that the most effective listening platform is a submerged submarine. In this respect, it is interesting to note that, of the many units in the Navy's ASW team—destroyers, ocean station ships, antisubmarine support carriers, long-range patrol planes, helicopters and blimps—submarines have the greatest detection (listening) capabilities.

Our submarines, in addition to having long-range sonar to hear, also have the fire control to figure the distance, range and speed of an enemy submarine as well as the weapons to kill it.

Our modern subs are equipped with automatic computers which resemble an electronic brain. These computers digest the data received from the sub's sonar, gyrocompass and underwater log, and predict the target's position on weapon arrival and aim the weapons. With the permission of the sub's skipper, which he may give by simply throwing a switch, the computer can actually fire the weapon.

THE WEAPONS IN this case are torpedoes. Usually they are high speed, long-range acoustic homing torpedoes which leave no tell-tale bubble trail. They guide themselves to the noise emitted by a moving submarine. They are equipped with a device which prevents them from turning or homing against the firing submarine.

Another underwater-to-underwater weapon—one with delayed action—used extensively in ASW, is the submarine-laid mine. Today, our subs are capable of determining their exact navigational position while submerged, and can then lay these deadly "eggs" from their torpedo tubes in the location where they will do the most damage to enemy submarines and shipping. Mobile mines have been developed which permit the submarine to remain outside an enemy harbor and plant a minefield in the harbor many miles away.

Mining and torpedoing enemy submarines are but two of many ways which our subs may be used in ASW. The Navy has a special unit, Submarine Development Group Two, for the sole purpose of developing new tactics and techniques for the submarine's role in ASW. It was established in the spring of 1949 under orders from the Chief of Naval Operations. Based at New London, Conn., SubDevGru Two is headed by Captain R. B. Lynch, USN. Under his command are the "killer" subs, USS *Barracuda* (SSK 1), *Grouper* (SSK 214), *Cavalla* (SSK 244) and *Blenny* (SS 324).

ALTHOUGH three of the submarines carry the SSK designators, they are not much different from the Navy's other 115 operational subs. Today, the majority of our submarines have SSK capabilities. Since the end of World War II, the primary mission of our submarines has been changed from destroying surface ships to sinking enemy submarines.

According to Captain Lynch, the submarine is this country's most forward line of defense. It can go where no other unit would survive. In the event of war, our subs would be sent into the enemy's home waters to destroy its submarine fleet.

Captain Lynch feels that *Nautilus* is without a doubt this country's best ASW weapon. "Her primary job is to kill enemy subs. She's well trained and has proved herself capable of doing that," he said. "If a submarine can sink another sub then there's nothing it can't sink—sinking surface ships takes lesser skill." During recent NATO maneuvers *Nautilus* remained submerged a total of 14 days, 13½ hours, and left behind a trail of "damaged and sinking" surface ships.

After this operation, the skipper of *Nautilus* said that a "major scientific breakthrough" will be necessary before capital ships have the means to defend themselves against nuclear subs. Speaking of the world's first atomic sub, CDR Anderson described her as "the deadliest enemy of surface ships and other submarines ever devised by man."

THE ADVENT of our nuclear subs has again given the submarine the offensive advantage over our antisubmarine capabilities. Our anti-

submarine warfare forces have already learned valuable lessons from operating with *Nautilus*, *Seawolf* and *Skate*. As a result, the Navy, working with scientists and industrial engineers, is making a major effort to develop the equipment and weapons necessary to defeat the nuclear-powered submarine.

The nuclear submarine is, in itself, a powerful submarine killer weapon. It has great advantages over the conventional guppy submarine and can be a deadly hunter and killer of nuclear subs as well.

As of now, no announcements have been made officially as to other navies' having nuclear submarines in operation. But, in anticipation of the introduction of nuclear submarines in other fleets, the Navy is no longer building conventional subs and is designing its nuclear submarines primarily as submarine killers. In doing this, however, the Navy is not overlooking the great potential of the nuclear-powered guided missile submarines. These will also be designed and built in balanced numbers. Our guided missile subs which have already been developed will be an important addition to the striking power of our attack forces. And it is expected that the *Polaris*-launching, nuclear-powered, guided missile submarine of the near future will be one of the country's most versatile and powerful deterrent weapons.

Although SubDevGru Two works extensively with our new nuclear submarines, the majority of its operations are in direct relationship with the guppy-type submarine. After all, SubDevGru Two has the task of determining how to use most effectively the submarines and equipment available today. It's the guppy-type submarine which makes up the bulk of our submarine forces and they will be weapons of great importance for many years to come—until replaced by nuclear boats.

THE MAJORITY of our submarines in operation today are World War II boats which have been streamlined, had snorkel and improved sonar added, and been given increased battery power. A few of our conventional subs—the so-called fast attacks—are of new construction, and incorporate all of these features. At present we have three nuclear submarines in operation, two more nearing completion, and 16 others in the buildingways.

Our conventional submarines, as well as our nuclear boats, are playing and will continue to play a most important role in antisubmarine warfare. During peacetime—in both the Atlantic and Pacific—our submarines operate independently or with other ASW forces. Through these operations, our subs have greatly improved their antisubmarine warfare equipment and tactics to the point where they are capable of meeting conventional submarine threats.

In the event of war, our submarines would carry out their primary mission of conducting antisubmarine warfare. Acting as sub killers, they would operate alone or in packs.

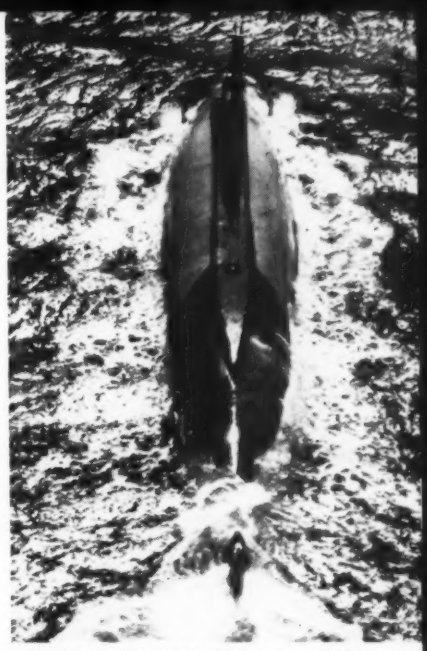
It is entirely probable that future underseas encounters between our own and enemy nuclear-powered and conventional submarines would be equivalent to an aerial dogfight. These battles will be fought at deep submergence and at high speeds. The winner will be the one with the best maneuverability, the best sound equipment, the least self-noise and the most effective, high-speed, deep-running, antisubmarine weapons. In carrying out their role as sub killers, our subs will also team up with aircraft and surface ASW units.

So far as other phases of ASW go, our submarines will be used to support and supplement our fast carrier striking forces. Days or weeks ahead of a carrier strike against enemy submarine installations, our subs would be sent into enemy waters to act in the capacity of antisubmarine barriers and minelayers.

Immediately before a strike by our carrier forces, our guided missile subs would be sent in to destroy any enemy objectives which might present a threat to our attacking carrier forces. Guided missile submarines—which give the Navy a weapon of unprecedented stealth and secrecy—can also be used as part of the striking force and can destroy targets of naval interest. Most important in the first phase of ASW, they can destroy enemy submarine installations before the enemy subs have a chance to get to sea.

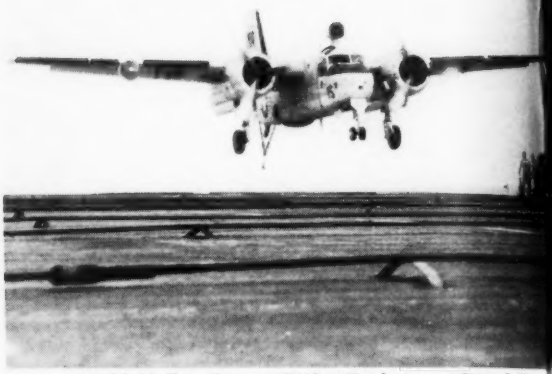
It is these capabilities of stealth and forward deployment which make our highly versatile submarines—whether nuclear or conventional—such a vital part of the Navy's overall air-surface-underwater team.

—H. George Baker, JOC, USN.



FAT BUT FAST—*USS Albacore* (AGSS 569) has hull design that will give A-subs greater speed for hunting.

PLENTY POTENT—Conventional type subs are rigged and trained for ASW.



ON DECK—A3Ds can knock out sub's home port. *Rt:* S2F returns to *USS Valley Forge* (CVS 45) during ASW drill.

AIRCRAFT in ASW

EVERY ASPECT of naval aviation, from the transport winging its way over the ocean, to the sleek jet bomber flying an infinite variety of flight paths, is concerned with one or more of the three phases of anti-submarine warfare.

No element has been overlooked as the Navy tightens its defenses against a possible submarine menace. The supersonic jet fighter, the hovering helicopter and nearly all other Navy aircraft have been assigned either primary or secondary ASW roles as they join with surface and sub-surface forces against the common submarine enemy.

The striking force of the Navy air arm has been alerted for missions in support of ASW Phase One in time of war: That is, the destruction of the ways where enemy submarines are being built, their supply bases, and the submarines themselves as they head through coastal waters out to sea.

For this mission the naval air arms in the Pacific and the Atlantic rely on formations of carrier-launched attack planes.

For the most part these planes are speedy jets, capable of making their way to a distant target with comparative safety.

These offensive forces have wide latitude of operation: They could move in over a target area at 40,000 feet in a bombing attack or they could "loft" their loads into the target area while zooming up from the sea level. Aircraft equipped with guided missiles could stretch the Navy's reach even farther, striking at distant targets without leaving the zone of safety.

This same striking force has still another weapon: Air-delivered sea mines to block channels in order to destroy submarines returning from the open sea or to seal them in harbors.

Pure ASW aircraft enter the picture in Phase Two of ASW: Destruction of the enemy on the high seas. Here the twin-engine S2F *Tracker* aircraft and HSS helicopters carry on the air war against subs from the decks of aircraft carriers attached to a HUK force (see story, page 24).

Phase Three puts the Navy air offensive patrol on the move against possible penetration of our coastal defenses by guided missile-bearing submarines. Large land- and sea-based patrol planes fly detection missions back and forth along our extensive coastlines. Blimps also operate in this area utilizing basically the same detection equipment. Their weapons include homing torpedoes, depth charges, nuclear depth bombs, rockets, cannons and bombs.

ATTACK PLANES

THE TASK FACING ANTISUBMARINE forces in a big conflict is dependent on the success achieved in striking force attacks against enemy submarine bases and building yards. If the raids against enemy harbor and coastal cities are successful, fewer and fewer submarines will be encountered at sea by HUK forces. But, if the attacks are not successful the oceans will continue to swarm with fresh enemy subs.

Destroying the facilities that serve as support to enemy submarine forces is the job of the striking elements of the Navy air arm. The attack planes that muster with this force today include the A3D jet-driven *Skywarrior*; A4D *Skyhawk*; AJ *Savage*; and AD *Skyraider*—all currently deployed with the Fleet.

Kingpin of this group is the A3D *Skywarrior*, a swept wing bomber capable of speeds in excess of 600 mph. Driven by two jet engines hung in pods under the high wings, and manned by a crew of three, the *Skywarrior* can carry the largest types of bombs, including nuclear weapons, over thousands of miles. Aerial refueling further extends the range of this high-altitude attack plane which can also make low-level mining and photographic runs.

The A4D is the Fleet's smallest atom bomber and is rated superior to many jet fighters which weigh twice as much. This 700-mph-jet can travel from coast to coast without refueling.

The *Savage* is a composite-powered carrier-borne attack bomber. It uses two reciprocating engines in wing nacelles and a turbojet engine buried in the fuselage. It can strike far inland with atomic weapons and then return safe to the carrier. Another version of the AJ is used as a tanker plane, refueling faster jet striking units sent on long-range missions.

The *Skyraider* has long been the workhorse of the naval air fleet. It is produced in several different models in addition to the single seat

EVEN FAST flying jets get in the ASW act by protecting bombers striking at submarine bases and supply ports.

attack version. Capable of carrying a wide variety of weapons into combat, the "Able Dog" has a combat radius of 1000 miles and a speed of nearly 300 mph.

Since the mission of the striking force includes destruction of large facilities as well as single units, the aircraft weapons are many and varied. Rockets, bombs and missiles of various sizes are used in attacking surface targets. Nuclear bombs and other atomic devices are used to destroy building yards or sub pens and, in the case of heavily defended targets, "stand-off" missiles penetrate the defense wall while the carrier planes stay safely out of range.

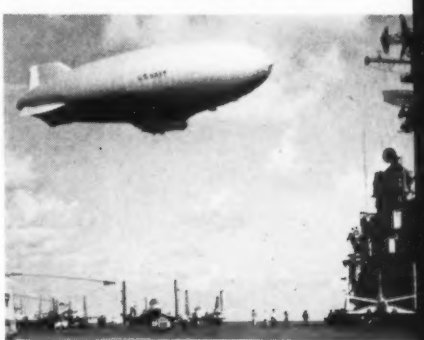
Patrol Planes

A CREW OF TEN — two-prop and two-jet engines — the latest in detection gear — plus the ultimate in weapons — these are the components of the Navy's long-range threat to enemy submarines, the P2V-7 patrol plane called *Neptune*.

These planes, packed with electronic gear and skilled personnel, fly long-range missions to detect submarines while they are still out of guided missile range. They have the ability to attack and destroy, but can call on the specialized talents of the HUK group to stop the underwater enemy.

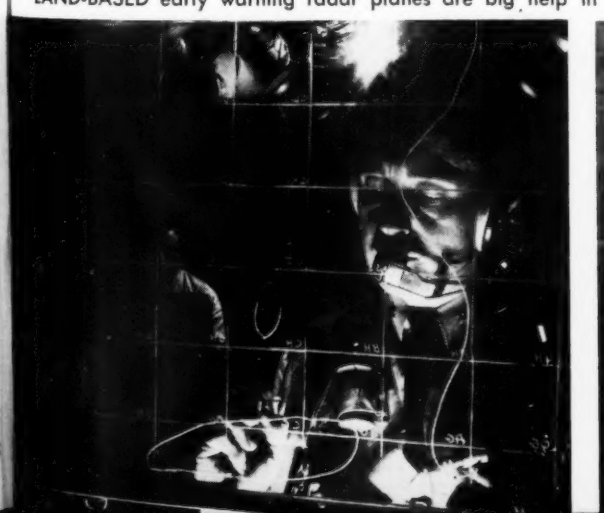
A typical search mission would begin at any coastal Naval Air Station where a *Neptune* Patrol Squadron (VP) is based. The twin-engine plane, which is boosted into the air and given higher performance by two auxiliary jet units, is doubly inspected before takeoff, valuable insurance for a plane that will be over the ocean for more than half a day with no stopping for repairs.

Every panel of the 100-foot wing assembly is checked while enlisted technicians test their sonar, radar and magnetic detection (MAD) gear. Ordnance crews install a variety of weapons which might include the vaunted nuclear depth bomb *Betty*, or the MK 43 homing torpedo.



NAVY BLIMPS and helicopters are well known for their role in ASW.

LAND-BASED early warning radar planes are big help in fighting subs. *Left:* Sub's course is plotted in WV-2.



THAR SHE BLOWS—*Neptune* patrol bomber with ability to locate and destroy subs finds its target during practice.

Instruments, controls and survival gear are inspected, the two 2500 hp motors warmed up and the plane roars off on a mission that may last as long as 13 hours.

The search pattern flown by the plane may cover a specified zone selected by the antisubmarine command or it may be based on sub sightings made by Coast Guard, merchant or Navy ships, and civilian or military aircraft. Once over the search area the plane will cruise back and forth at 170 knots sweeping the area with the magnetic detection gear. Airborne radar will seek the tiny pips that will indicate a protruding periscope or snorkel and electronic counter measure gear (ECM) will attempt to intercept the electrical radiations of communication and detection gear aboard the sub. When the sub is detected sonobuoys will pinpoint its location.

The search may continue for hours. Even with all of this electronic equipment, visual observation is still necessary, but after long hours of flying it becomes difficult. The formless sea will play tricks on the eyes of the visual observers until they might call whales, destroyers, oil slicks or even shoals, submarines.

If a sub is sighted and identified as being potentially unfriendly (peacetime procedure) it will be followed, photographed if possible, and other ASW forces brought to the scene. In wartime a detected sub will be subjected to attack. Rockets and bombs will be used if the sub is surprised on the surface, and torpedoes and depth charges if it is detected while submerged.

To accomplish this, it is necessary to have a well trained crew, good equipment and a stable platform. Navy training schools provide the crews, American industry the equipment and the P2V-7 long-range patrol plane, the platform. The ability of this high-wing plane with its engines slung beneath the air foil to fly long distance non-stop was proved in 1946 when an early model flew 11,236 miles without refueling. The plane takes to rough weather like a duck to water and the *Neptune* has made many low-level penetration flights into hurricanes.

When parked on its tricycle landing gear the plane looks cluttered with equipment. Beneath the slim fuselage is a large pod containing electronic gear. Each wing is tipped by large tanks; one contains a powerful searchlight, the other an electronic antenna. The tail has been stretched out for installation of MAD units.

Some models of the P2V have been rigged for low-level antisubmarine minelaying missions. Operating from advanced bases they could block the exit of enemy sub bases. But, whether they are assigned to cooperate with a HUK group, cover a convoy, lay mines or conduct long-range searches, the P2V-7 and the men of the VP squadrons will continue to be a deadly threat aimed at enemy submarine fleets.

SEAPLANE: MARLIN

FOR EFFECTIVE COMBAT against modern submarines that literally "fly" underwater, the Navy uses "boats" that fly above water, the P5M *Marlin* patrol seaplanes.

These seaplanes, operating with various Atlantic and Pacific patrol squadrons, have been assigned to the coastal antisubmarine defense program and also in advanced areas of operations. Capable of staying airborne for 11 hours, the *Marlins* carry the latest types of detection gear and destructive weapons.

The ASW operations of a *Marlin*-equipped patrol squadron (VP) in coastal waters will range from flying cover over convoys to mining approaches of areas where enemy submarines might hide. When deployed in the forward area, a VP outfit might find itself operating from an uncharted cove or bay, taking fuel

WATER WINGS—'Ground' crew checks plane in the water. *Right:* Repairs are given P5M in Landing Ship Dock.

from a submarine and having its planes repaired in a special LSD. During flght operations, the squadron's planes might provide ASW cover for a carrier striking force or an amphibious operation or cover a segment of convoy routes. Any one of these roles fits the *Marlin* like a glove.

The *Marlin* seaplane has a strange appearance in this age of swept-wing supersonic planes. The water-tight hull looks high and bulky perched on the auxiliary wheels that are used only for beaching. The two 2500 hp piston-type engines slung under the high gull-shaped wings look almost too small to pull this 60,000-pound aircraft into the air.

But in this case appearances lie. Cruising at a speed of 130 knots, the *Marlin* can use its detection gear to great advantage. This slow speed, still many times faster than a sub, allows its hull to be eased into a water landing with a feathery touch and *Marlin*-carried ASW weapons can be laid right on the target.

Indicating the presence of detection gear is a large radar dome on the nose and a MAD gear rod protruding aft from the high "T" shaped tail. This arrangement of the MAD gear "divining rod" is found only on the second model (P5M-2) of the *Marlin*. The first model had the horizontal tail located in a normal position. Sonobuoys further increase the *Marlin's* detection ability.

The two bomb bays of the big plane are located in the nacelles aft of the radial engines. Under each wing are other racks which can accommodate various types of weapons including homing torpedoes, rockets, bombs and depth charges. Mines can also be carried by the versatile seaplane which also features a 70 million candle-power searchlight on the starboard half of the 118-foot wing assembly. This powerful light can spot a submarine at a range of more than one mile.

The beauty of patrol squadron seaplanes is their mobility. One day they can fly missions from the seadrome at the Naval Air Station, Norfolk. Twenty-four hours later they can be moored to buoys at an advance base 1500 miles away. Their deployment does not hinge on the capture of an air field or the construction of hard runaways. They use the water as their runaway and can be serviced by seaplane tenders.

To operate these planes a P5M squadron will have a complement of 55 officers and about 300 enlisted men.

The ability of the P5M-2 *Marlin* seaplane to operate in conjunction with other forces from nearly any point on the 70 per cent of the earth's surface covered by water, its long range, and its assortment of weapons and detection gear have made it an important unit in the antisubmarine defense force.

LIKE A DUCK—Using world's waterways for landing fields P5M Marlin can fill many roles in ASW program.

SEA JET—P6M *Seamaster*, a near supersonic swept wing sea plane will join the Fleet as an important ASW weapon.

On the Way — Seamaster

THE P6M *Seamaster*, a swept wing seaplane powered at near-supersonic speeds by four jet engines, has been assigned a leading role in anti-submarine warfare even before it has completed flight tests.

Forthcoming production models of this 600-mile-per-hour minelaying seaplane will be used to strike at enemy submarines in their home ports in the event of any big war. Refueling from submarines or other small units en route, the long-range seaplane could deliver mines or nuclear weapons against any target within range. This includes any target that lies within 2000 or more miles from the *Seamaster* tenders or advance bases.

Seamasters deployed with the Fleet might be dispersed in small units within striking distance but out of the range of surprise attack. They might fly missions from one base, then move to a sheltered bay or cove to be serviced by a tender or advance base crew.

Flight tests now being conducted are a resumption of a test series which ended with the loss of the first two experimental planes of this design. The new prototype *Seamaster* has many improvements over the earlier models and five more P6M aircraft are now under construction and will be delivered to NATC, Patuxent River, Md.

The six evaluation planes, designated YP6M-1, are powered by four J-71 turbojet engines. Eighteen additional *Seamasters* under construction (P6M-2) will be driven aloft by J-75 turbojet engines. The plane now undergoing tests has its engine nacelles, mounted on top of the sharply swept back wings, canted outwards to avoid heating the fuselage when the two inboard afterburners are used. This heating was experienced on earlier models of the new plane.

Other design improvements made on the new models include an improved configuration of the engine nacelles to increase engine performance and addition of a new tail fin fairing at the top of the fin to reduce in-flight drag.

During the current test series, four F11F-1 *Tiger* jet fighters, equipped with camera guns, are being used as chase planes. The supersonic *Tiger* is better able to keep up with the swift *Seamaster* than were earlier fighters assigned to the task.

This versatile aircraft can perform high-speed photo-reconnaissance as well as minelaying and bombing missions. It has the latest in aircraft equipment. The bow contains a radome and behind it are the pressurized flight deck and crew's compartment. Here the pressure never falls below that found at 21,000 feet even though the plane may be flying at 50,000.

The crew includes a pilot, co-pilot, navigator, bombardier and radio operator. Behind this pressurized cabin is the mine bay which extends up into the wing section. This rotary unit is watertight and can be loaded with mines, supplies or camera pod while the plane is in its beaching gear or afloat. If necessary the rotary mine bay can be removed and replaced with a loaded unit.

A large mine-loading hatch is located in the top of the hull aft of the wing directly over the mine-loading compartment. If it is necessary for the crew to go into the tail section during flight they can travel on an overhead track and trolley system.

The wings (span, 100 feet) are tipped at each end with metal floats. When the *Seamaster* is down on the water the wing tips touch the surface and these floats provide additional stability.

Once these planes become fully operational they will be examples of the mobility of sea power. The force of P6Ms will be able to roar over a target at high altitude to launch their nuclear bombs against submarine bases or shipyards, or, under different circumstances they can take off on a mining mission that will find them streaking at nearly top speed a few feet above the water. When the mines have been dropped the plane will turn for home, but this time it may be a new home a thousand miles from the point where the flight began.

A tender vessel (landing ship, dock; submarine, or seaplane tender) will be waiting for the arrival of the combatant P6Ms.

The importance attached to this ability by defense officials marks the resumption of P6M tests as a significant advance in the development of a major new ASW striking weapon.

—William Prosser, JOC, USN

Protecting Our Harbors

A GIANT TROOPSHIP anchored in a harbor is suddenly shaken by an underwater explosion. A merchant ship, headed for sea through a narrow channel, actuates a recently laid mine and sinks. The caisson which holds the water out of a drydock is split by a torpedo, and the warships inside are badly damaged by the wall of water rushing in.

In the scene described, a frogman, slipping out of a midget sub, attached the explosive to the keel of the troopship. A small submarine laid the mines in the channel which sank the merchant ship. A Fleet submarine, entering the deep water harbor by sailing under an inbound warship, fired the torpedo which destroyed the drydock.

These are the man-made disasters that U.S. naval harbor defense forces are deployed against.

Such disasters *have* happened.

During World War II, USS *Tirante* (SS 420), for example, entered a confined harbor that was guarded by air and surface ASW units. Further, its shallow waters were crowded with mines. *Tirante* torpedoes caused the destruction of a 10,000-ton tanker and two new frigates before the submarine retired.

Harbor defense is just one part of the antisubmarine warfare program discussed in this issue—but an important part. A basic mission of ASW is to bring the battle to the enemy sub at its base or on the high seas, but defensive measures prepare for the possibility that a sub may slip through and attempt to enter or mine the approaches to a harbor. Consequently the continued emphasis on harbor defense.

In defending a harbor, preparations call for both the detection and destruction of an enemy intruder. Various types of detection gear are installed in the defense system to locate these intruders. For example:

- Magnetic indicator *loops* (large rectangles of cable laid on the ocean floor) create an invisible detection barrier across the harbor entrance. These loops record any distortion of the natural magnetic field caused by an iron or steel body crossing the cable.
- Sensitive *hydrophones*, tripod-mounted on the harbor bottom, listen for machinery or propeller noises of a submerged submarine or sneak craft. The operator ashore is able to estimate the position of the intruder by switching from one hydrophone to another and comparing the intensity of the sounds received.
- Radio *sonobuoys* floating on the surface train their "ears" on a source of underwater noise to give further evidence of position, but the actual pinpointing of the target is usually done with the *herald*. This active sonar equipment, mounted on the harbor bottom, is controlled by an operator ashore.
- The surface of the water is scanned by *radar*.
- The eyes of *lookouts* are trained seaward to detect any penetration attempt.
- *Patrol boats* and surface and air ASW units patrol the harbor entrance and approaches.

All of these detection systems forward their findings via cable or radio to operators in the Harbor Entrance Control Post where the defense of the harbor is coordinated. Here the crew regulates traffic into and out of the harbor. Ships arriving are challenged well outside the harbor by an examination vessel and, if not properly identified, they are ordered to an examination area. Those cleared to enter are guided through swept channels by navigational aids.

These are routine missions for the harbor defense forces, but their job is not routine when a meter on a magnetic loop system indicates an unidentified craft is crossing the cable.

The short-pulse herald and sonobuoy operators tune their equipment with precision. Hydrophones detect the thumping sound of a small engine in the outer detection area and a short time later heralds are receiving echoes that disclose the range and bearing of the target.

If the object, without being identified as friendly, enters the hunting area of the harbor, which overlaps into both the outer and inner detection zones, it is attacked by patrol craft which receive their instructions from the Harbor Defense Commander. Special picket boat charges developed by the Navy for defending harbors and inland waterways are launched from the patrol craft. The charges are lightweight but they pack a powerful punch.

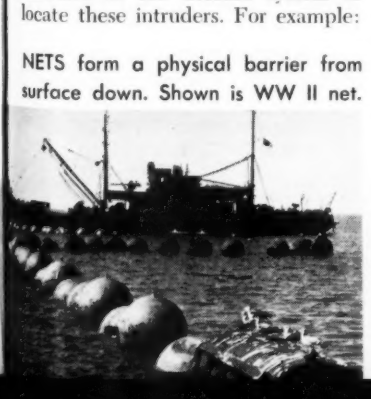
The final barriers the enemy must penetrate are the minefields and the nets guarding the anchorage area. Fields of controlled magnetic mines are laid in and near channels outside the protected anchorage area. The magnetic units sense the presence of iron or steel objects and indicate this on electronic equipment in the Harbor Entrance Control Post. With this knowledge the Harbor Defense Commander can order the detonation of the proper mines, destroying an enemy intruder. This method of mining safeguards friendly surface ships passing through.

The net defense can be described as a heavy wire fence, stretched across the harbor entrance, supported by buoys and dropping down to the ocean floor, forming a physical barrier capable of stopping submarines, torpedoes and sneak craft.

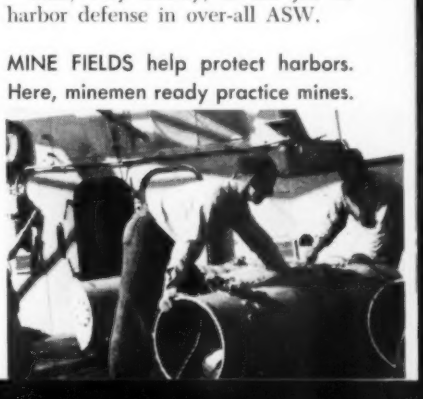
To permit shipping to move in and out of the harbor, a net gate is installed. The opening and closing of this gate is controlled by the Harbor Defense Commander and is accompanied by increased vigilance, since this is an opportune time for an enemy submarine to try to penetrate the net defenses. Inside the net line more patrol boats move back and forth guarding against swimmers, saboteurs and any craft able to penetrate the nets.

This, very briefly, is the job of harbor defense in over-all ASW.

NETS form a physical barrier from surface down. Shown is WW II net.



MINE FIELDS help protect harbors. Here, minemen ready practice mines.



HAVE A BALL—Hovering helicopter lowers sonar ball toward water. *Below: USS Essex* (CVS 9) is all decked out for ASW as she receives supplies at sea.

The HUK Tec

TO KILL A SUB, you don't just go out and look for one. First you have to know where a sub might be. This can be done by a number of methods—by a sighting from any of 4000 Allied merchant ships at sea each day, a chance underwater contact, or by other intelligence reports. When a report of this nature comes in, one of the HUK (Hunter-Killer) groups moves into action—fast.

What is a HUK group? Simply stated, it is a team—a team that uses all capabilities and all available weapons to hunt, detect, and kill submarines.

The submarine on patrol during early World War II had little to fear except the few escort ships that accompanied convoys, or an occasional patrol plane. With the advent of antisubmarine hunter-killer groups however, that roam the midocean areas, the submarine is subject to surprise attack at any time. The present-day submarine must be constantly alert against attack without warning from above, below or on the surface—for he is never "out-of-range."

THE SPEARHEAD OF THE NAVY'S effort against submarines is the antisubmarine carrier task group. The center of this task group is an *Essex*-class carrier which has been converted specifically for antisubmarine work. On these carriers are based the S2F *Trackers* — a twin-engine, high performance aircraft designed solely to detect and attack submarines. The carrier also carries jet fighters and a detachment of antisubmarine helicopters, especially built as submarine hunters.

Accompanying the carrier is a group of fast escort ships. These are generally the workhorse destroyers (see page 8), but a portion of them may be special antisubmarine destroyers.

When a submarine for any reason betrays its presence, the high mobility of the antisubmarine carrier and its escorts enables the task group to race toward the contact. As the group approaches the submarine's estimated position, the escorts in a line ahead of the carrier search the surface of the water with their radar, to catch the sub on the surface or—if it has been able to submerge in

time—search beneath the water with their sonar.

The *Tracker* aircraft meanwhile are launched, and they fan out over the possible contact area. They search thousands of square miles of the surface of the sea during each hour.

Far from the carrier and destroyers, a radar operator aboard one of the *Trackers* observes a dot on his radar scope indicating a possible contact. Word is radioed back to the task group. The attacking force moves into operation as helicopters and additional *Trackers* are launched, and a destroyer detachment is dispatched from the main group to get the submarine.

PLANE BLOOD HOUND—S2F *Tracker* extends its detection gear to hunt sub.

Team: Navy's Hunter-Killer

If the submarine eludes the original detector, teamwork comes into play. Still more *Trackers* intensify the search, and the helicopters arrive to add the detection capability of their sonars to the search effort.

The search and kill potential of the antisubmarine element is greatly increased with destroyers. Their sonar and radar search continuously for the sub, and their weapons are ready for attack. Escort destroyers may attack the submarine in various ways. (See page 9.)

DURING ROUTINE ANTISUBMARINE exercises, the over-all mission is to develop coordination between surface, heavier-than-air and lighter-than-air craft in searching for and attacking submarines, and in convoy screening and protection.

In addition, opportunity is provided to the participating submarines for practice in convoy detection, screen penetration, and attack.

In actual combat, the submarine wouldn't get the opportunity. The purpose of exercises is to develop and improve tactics, doctrines and operating procedures in the field of combined airborne and surface antisubmarine warfare.

In one type of exercise the submarine is told to try to penetrate the screen and attack the carrier. In another, the carrier takes evasive action while the helicopter and planes make their runs on the submarine.

In still another, the destroyers pick up the contact, and make their runs on the submarine. Or they can take charge of the planes or helicopters and vector them to "sink" the sub.

In one phase of a particular exercise, a carrier like *Valley Forge* (CVS 45) would have about five destroyer-type ships guarding her. At the same time, these guarding ships would be taking up their submarine search positions. To fill in the search gaps these would be the weapons of the carrier—S2F *Trackers,* AD *Skyraiders* and HSS-1 helicopters.

HOW DOES THE HUK group operate? With the destroyer-type ships in the screening and search positions around the carrier, pilots and plane crew members "suit up" in the ready room. During the briefing, wind, weather, ship's course, radio frequencies, and possible contact areas are scribbled down on pads.

Last-minute drags are taken on cigarettes and lifejackets are checked. Then out of the ready room these men walk, with helmet in hand, to the flight deck or ride one of the elevators to their planes.

On the flight deck, men in brightly colored jerseys are performing what looks like a smoothly operating ballet, checking last minute details on "their" planes before the flyers climb aboard.

A quick glance by an experienced carrier man can tell that the men in green jerseys are members of the catapult and arresting gear crews or photographers or mechanics. Plane captains are easily spotted by their brown jerseys.

Bright yellow denotes plane directors, elevator operators and officers. Plane handlers are decked out in blue. Standing around are the men in red jerseys. These are members of repair parties, refueling crews, firefighters or ordnancemen.

First to take off is the HUP helicopter. Known as the "Angel," it takes up its position near the bow of the carrier. In the unlikely event of a plane crashing into the water, the HUP would have the crew pulled to safety in a short time. One of the destroyers trails the carrier for the same reason during takeoffs and landings.

The carrier has picked up speed, turned into the wind and planes are manned. At a given signal, engines are started with a pop or cough or whine. Helicopters lift themselves straight up to take up their area of search and help screen the carrier.

A yellow-jerseyed man stands in view of the pilot of the first plane and holds a red flag in his hand to show that the propellers are turning, but warning against takeoff. This flag is soon replaced by a green one and throttles bring the engines to life with a full-throated roar.

AS THOUGH STARTING A RACE, the green flag is pointed toward the end of the flight deck.

Making a takeoff from one of the hydraulic catapults, the plane gets a 2000-pound thrust and is hurled off into the air. Others roar down the long flight deck, sounding like a freight train coming, arriving and speeding away to join other planes on station.

The carrier returns to base course and speed, and the search is on.

One plane, designated as the "ready plane," remains on the flight deck, fully manned and armed,

ready to take off at a moment's notice to render asssitance or fill in a gap.

Phones are always on and the radio tuned to the combat channel.

The heart of any HUK group is the Combat Information Center aboard the carrier. The pulse-beat of the operation is felt in this semi-darkened room. Code names and call signs are grease-penciled on status boards which appear to be neon-lighted. Glass buttons on consoles light up like Christmas tree bulbs as phones are used. Some lights are bright red, others are orange, green and yellow.

Hanging from the overhead in strategic positions are speakers, each —in constant touch with a component of the group—to bring the "enemy" submarine closer to his end.

Helicopters, planes and destroyers are calling and are being called. A constant flow of information comes from men and pours into this room to be fed into computers or plotted on the DRT .

Pencil dots, like the tracks of a one-legged centipede, mark the position of the planes and ships and the target. Ranges, bearings, speeds, course, time and turns are only a part of the information that comes in and goes out.

ALL OF THIS INFORMATION is sent back to the carrier by the "scouts" of the team where it is sifted and sorted by the "coaches" in CIC and passed up to the "quarterback" of the team so he can call the plays necessary to make a score.

In this case the quarterback is the OTC (Officer in Tactical Command.) He is located a couple of decks above CIC in Flag Plot. From this vantage point he has a complete picture of what's going on around the carrier.

The OTC decides the cruising formation, what planes and helicopters are to be used, what weapons they will carry for a particular task, and where to search. He also directs the screen commander on changes and when to break off the search.

How do these weapons stack up? Take the S2F *Tracker*, for instance. It's quite a plane. In fact, it's two planes rolled into one, having replaced two modified TBMs, one of which had been the "hunter" and the other the "killer."

It takes a four-man crew to handle the two-engine *Tracker*, which can fly night hops as a matter of routine or fly in every kind of weather. It is armed to the teeth; loaded down with rockets, depth charges (including the atomic *Betty*), sonobuoys, and torpedoes. This plane can be vectored in to any attack, search an area ahead of the HUK group, or set up a barrier. Submarine detection can be made visually, by radar, ECM, searchlight or MAD (Magnetic Airborne Detection) gear.

Another weapon—or weapon platform—the HSS-1, is manned by a pilot, co-pilot and two sonarmen. This helicopter carries the ever-important sonar and TACAN (Tactical Air Navigation System). It is equipped with torpedoes and depth charges.

The copter is used in "integrated screen," that is, with surface elements of the HUK group, or it screens by itself. One of its primary advantages is the reduction of "time late" (the lapse of time between discovery of the target and arrival of an attacking unit).

Those are the weapons of an ordinary HUK group. But they could be supplemented by calling for land-based assistance in the form of P2V *Neptunes* or ZP blimps.

The *Neptune* is the Navy's fastest submarine hunter and, since it could remain on station much longer than the ADs or helicopters, would probably search an area or set up a barrier by itself. This type plane carries a pilot, co-pilot, radioman, plane captain, radar operator and ECM operator. Her armament consists of rockets, depth charges (including *Betty*), sonobuoys, torpedoes, searchlight and ECM gear. Her contacts are made either by radar or visually.

The blimp which, from the surface, looks awkward and clumsy, is actually an antisubmarine weapon which is many times faster than the speediest submarine. She can patrol or search an area or cover a convoy. And if she runs across anything, she carries the weapons to destroy it.

These blimps can land or be refueled from the carrier and continue their search. It is also possible, at the same time as they are refueling or rearming from the carrier, to change crews.

The role a submarine plays while operating with a HUK group places her a good distance ahead of the main group. Should this type submarine come across a contact, it's up to the skipper (one way or another) to get a radio message back to the HUK group commander and warn him of approaching danger. (More about subs on page 14.)

AS THE EXERCISE PROGRESSES, in the CIC the sweep arms of radar repeaters pick up contacts and leave their marks where anyone can see them. A staccato stream of conversation comes through a speaker as pilots talk from plane to plane. One

TRAIL MARKERS—In the combat information center aboard an Atlantic Fleet destroyer participating in ASW exercises, bluejackets chart hunt on plot board.

sub hunter calls in that radar contact has been made. This is followed by a visual contact report, and the announcement that the submarine is diving.

The rpms on the carrier increase. A sharply-answered command swings her bow into the wind. Two destroyers and helicopters break away from the screen and race to the target area.

So the screen of advance won't be disturbed, the remaining destroyers continue their progressive search while the other helicopters speed in front of the turning carrier and form their own screen. In this way, the carrier is protected at all times.

The HUP Angel takes up her guardian position again as the standby plane, already cut in on all the information, shoots off the end of the carrier to assist the attacking DDs and HSS. Other planes follow.

In a matter of minutes the launch is completed. The carrier, screened by the helicopters, returns to base course, closes up the formation and slows to the advancing speed. The helicopters now resume their leapfrogging sonar search tactics and strengthen the screen.

At the last known point of contact with the submarine, fixed-wing aircraft and helicopters are already on the scene. The S2F is making low-flying passes with MAD gear to pin the submarine down. The HSS-1, dealer of slow death to submarines, has its sonar ball lowered to pick up the sounds of the sub's propellers. The helicopter can practically roost atop its target, then drop its eggs.

A STORY THAT HIGHLIGHTS this bit of deception was told by one of the helicopter pilots who was detecting one of our submarines during an exercise. He had been searching an area where the submarine had been plotted in. Every once in a while he would bring the helicopter down to within 15-25 feet of the water and drop the sonar ball. The sonar operator would track the sub's course by propeller noises then bring the ball up again and the pilot would leapfrog to another position.

Repeating this a few times, he dropped down close to the water just as the submarine's periscope broke the surface to see what was going on in the outside world.

The periscope made a lazy sweep past the helicopter. "It was just like a double-take in the movies," the helicopter pilot said. "That periscope swept past us, stopped as though remembering something, spun back to our position to make sure he saw what he thought he saw and disappeared."

"Naturally," the pilot continued, "it was a definite 'kill'."

THE BOILING WAKES kicked up by the arriving destroyers flatten out as they cut their speed and take over the search. Two more sonar beams probe for a returning echo.

It comes—and the destroyers go into a two-ship attack.

Now the contact has been broken, and the search goes on again. Once again it is picked up and the helicopter is vectored into position to establish its own contact.

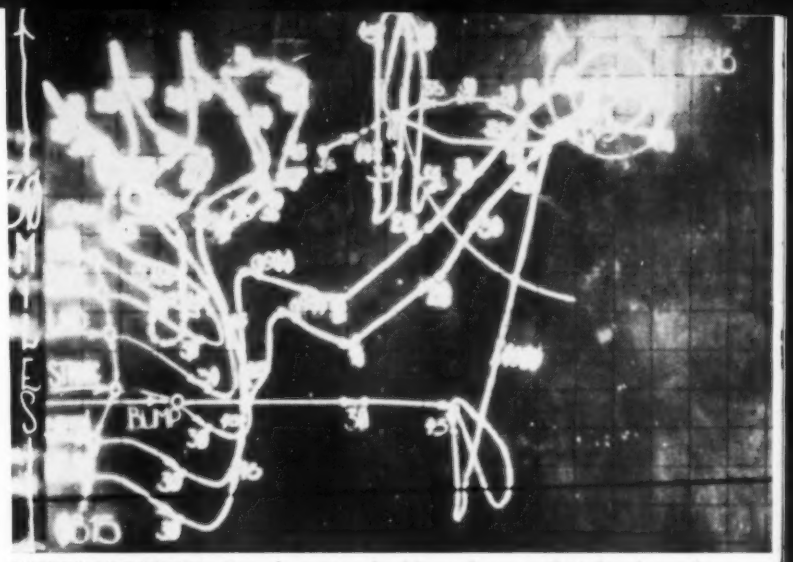
Another helicopter with "kill" weapons joins the attack. Now there is no escape for the submarine.

Our own submariners have great respect for the capabilities of the helicopter.

Maybe this is why the term "nuisance" applied to helicopters has been changed to "menace."

What is the reason for the amazing effectiveness of helicopters? Why do submariners now fear the heli'copter more than any other adversary? Here are four good reasons:

- Increased effectiveness of dipped sonar.
- Ability of positive identification and definite fix.
- Speed and maneuverability to provide rapid and effective screen over great areas of ocean.
- Invulnerability to attack from the depths of the ocean.



PATTERN OF DEATH—Complex network of lines shows paths taken by surface and air members of HUK team while tracking down and killing 'enemy' sub.

THE WORK-LOAD of an antisubmarine warfare aircraft carrier is usually distributed among eight basic departments which function as a smoothly running team to keep the ship at combat readiness. These departments are Executive, Navigation, Operations, Air, Engineering, Gunnery, Supply, and Medical and Dental. But they all add up to only one ship.

By the same token, the work-load of a HUK group is distributed among the carrier, planes, helicopters, blimps, submarines, and destroyer-type ships. Again, they add up to only one thing—this is one HUK group.

If you were defining the combined efforts of all of these weapon carriers in antisubmarine warfare, you could call it the joining of forces by uniting efforts and the cooperation of pooling weapons. But even this can be boiled down to one word—teamwork.

This is pretty well summed up by RADM John S. Thach, USN, Commander Carrier Division 16. He said:

"The submarine threat against the United States could be controlled or uncontrolled. The difference between the two may very well lie in the degree of *coordination* and *teamwork* we are able to reach in our ASW forces.

A classic example of complex coordination can be seen in the offensive ASW operations of the hunter-killer force."

—Thomas Wholey, JOC, USN

The Battle Viewed from the Per

AS TIME GOES ON, more and more men of the surface and air Navy are becoming increasingly familiar with the pattern of hunting—and being hunted—by submarines. This is in keeping with the growing realization that submarines are going to play an even greater role in any conflict of the future than they have in the past.

To date, this familiarization has been accomplished almost exclusively through antisubmarine warfare (ASW) exercises by naval vessels and planes known collectively as hunter-killer (HUK) groups.

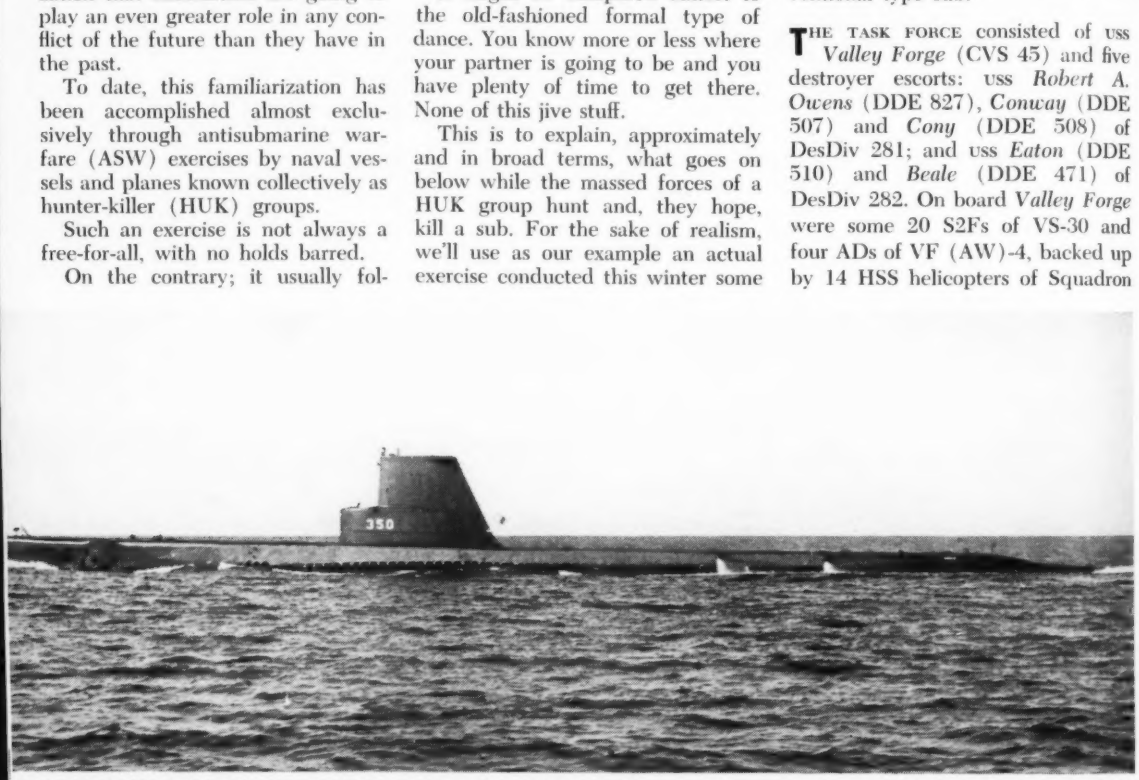
Such an exercise is not always a free-for-all, with no holds barred.

On the contrary; it usually follows a very definite pattern, so designed as to offer the most training to the various components of the HUK group, and is carefully graduated as to the various levels of proficiency of its members.

It might be compared almost to the old-fashioned formal type of dance. You know more or less where your partner is going to be and you have plenty of time to get there. None of this jive stuff.

This is to explain, approximately and in broad terms, what goes on below while the massed forces of a HUK group hunt and, they hope, kill a sub. For the sake of realism, we'll use as our example an actual exercise conducted this winter some hundred miles or so off the coast of Cape May, N. J., and ranging as far south as Norfolk. It just happened that the sub in this instance was USS *Dogfish* (SS 350). However, it could have been almost any conventional type sub.

THE TASK FORCE consisted of USS *Valley Forge* (CVS 45) and five destroyer escorts: USS *Robert A. Owens* (DDE 827), *Conway* (DDE 507) and *Cony* (DDE 508) of DesDiv 281; and USS *Eaton* (DDE 510) and *Beale* (DDE 471) of DesDiv 282. On board *Valley Forge* were some 20 S2Fs of VS-30 and four ADs of VF (AW)-4, backed up by 14 HSS helicopters of Squadron



LIFE BELOW IN ASW—Chief of the Boat R.F. York, EMC, checks control room gear onboard *USS Dogfish* (SS 350).

HS-3 (Det 52) and, for general utility purposes, one HUP helicopter from HU-2.

Dogfish had herself.

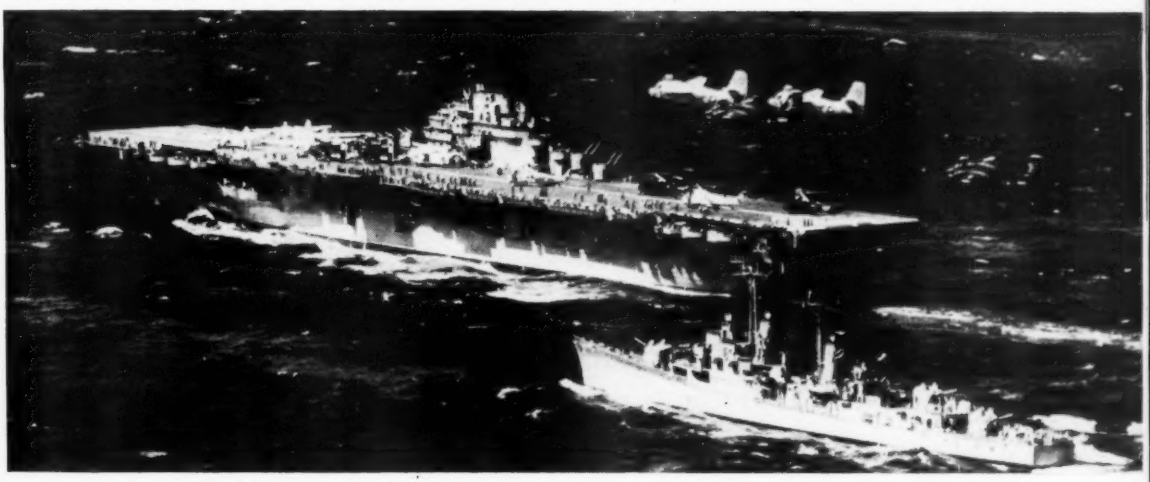
She had left New London, Conn., on Monday to rendezvous at 0800 Tuesday with the elements described above, which had meanwhile departed Norfolk. The trip down had been rough and cold. With an overall beam of 27 feet and length of 312 feet, *Dogfish* had been designed some 15 years earlier for speed, not comfort, and her skipper, LCDR J. W. Russel, USN, had pointed her bow in the direction he wanted to go and kept it there, regardless of the condition of the state-6 sea.

For 24 hours, all hands not on watch had clutched the edges of their bunks and had stared listlessly

at the overhead, their eyes blank and glassy. The only signs of life had been sudden—and frequently too late—dashes to one of the two heads. Those who had retained their sea legs over the preceding long weekend had offered cheerful promises of good rich pork for dinner and had otherwise run the gamut of outworn sea jokes. All in all, not a happy beginning.

Nevertheless, the wind had died down somewhat during the night and Tuesday dawned fair and warmer, with *Dogfish* on station at 0630. All hands regarded life with a new interest and appetite.

TOPSIDE—*USS Valley Forge* (CVS 45) with S2F *Trackers* starts ASW exercise. *Above:* Destroyerman maps ASW action.



THE FIRST PROBLEM gave promise of interesting action. At 0800, from a designated position she was to steam toward the approaching task force, which was then some miles away, and attempt to launch a simulated attack upon the carrier.

It was, of course, up to the DDEs and aircraft to prevent this and, if possible, destroy the sub before she had done too much damage.

Action started with *Dogfish* diving to intermediate level. In doing so, she left the world of the sea as most Navymen have known it for thousands of years. As she left surface (a matter of seconds only), the heave and pitch of the upper world disappeared and, except for the steep angle of her dive, she gave no sense of movement.

When she leveled, only the instruments in the control room indicated her progress. To most personnel on board, the next few hours were as if spent in a dream world. There was no throbbing of screws, no ventilator fans, no motors. Even voices (with the one exception cited below) were subdued.

Meanwhile, it grew more and more warm until all hands were sweating profusely and the air, never of the best, grew somewhat more foul.

The exercise, the carrier and destroyers, the planes, the preceding weekend and the weekends to come, were all far away.

As *Dogfish* dived, the crew had been sent to battle stations. In the forward torpedo room, bunks had been triced up and the crew lounged as best they could among the assorted gear and the torpedoes with their dummy warheads.

To conserve batteries, the room was dimly lighted. Most of it was in semi-darkness except far forward, where the torpedo tubes and their controls shone brightly. There was only casual conversation between the crew, primarily concerned with lies about their accomplishments and adventures over the preceding weekend.

The talker, A. L. Clark, ETC, USN, passed the word on what was happening. "Right now, we got a DE headed right at us. Looks as if they spotted us and got us zeroed in. A perfect position for a down-the-throat shot. Those fighting gents in conn, with their trusty little slide rules and dividers say they have done just that. Damn, I wish those things were loaded and we could fire them.

"Anyway, we just blew him sky high, simulated—that is."

LOOKOUT—More than once a sub has been able to get sights set on some hunters during maneuvers. Here, 'enemy' sub sights HUK group thru its scope.

"Whatta clown," muttered a heavy voice in the background. Clark was the type who, no matter on board what ship, would inevitably be chosen as Neptunus Rex at all crossing ceremonies. He was built for the role. He also constantly bullied the men and conned the officers into behaving the way he thought best for *Dogfish*. In theory—and according to the book—*Dogfish* belonged to the Navy; in practice, it belonged to Clark.

If a man got too much on his shipmate's nerves, it was Clark who had a quiet word with him. If a man was in trouble, he had a word or so with Clark. It was he who dropped around to see the three gifted—if temperamental-cooks, Robert R. Barry, CS1, USN, Ramon D. Baney, CS2, USN, or Ronald G. McCullough, CS3, USN, when any one of them became disgusted and threatened to throw the whole mess overboard. It was also Clark who had designated McCullough as "Sir Salisbury, Knight of the Ground Round." McCullough had, so it was alleged, made the mistake of serving hamburger twice in one week.

A sound as of an elevated train passing in the far distance came and went. "That was the DE we just killed," explained Clark. "We're taking evasive action all over the place and they're going crazy up above. They've lost us.

"Sonny, that little spit of white you see on the scope is the carrier. Looks as if we're going right under her. Ahhhhh, if only we could use those torpedoes. What a splash she'd make!"

SHORTLY AFTER THE WARNING "Rig ship for deep submergence," *Dogfish* went into a long steep glide, then leveled off and again seemingly stood still. Otherwise, no change.

"Join the Navy. Learn a trade and see the world," came a voice from the background. "They didn't say anything about Clark. No wonder we get hazardous duty pay."

"Buster, they didn't know you'd be lucky enough to get on the same boat as Clark, or they'd 've told you soon enough. You've got Clark here to wipe your little noses when you get homesick and you've got Clark here to tell you what's going on in the great big outside world. He's going to do it, too, if he has to lash every one of you down to the deck."

There was a sharp rap on the hull directly overhead, as if it had been struck smartly with a small sledge. For the purposes of the exercise only, grenades had been substituted for the offensive weapons of the hunting forces—potent enough to let the sub know she had been hit, but not strong enough to do any real damage. In turn, the torpedoes had been filled with plaster instead of explosives.

Throughout the boat, eyes were directed to the overhead, then dropped as if their owners were slightly embarrassed. In the control room, swarthy, tousle-haired 19-year-old Joe Paglia, EMFN, popped his bubble gum defiantly at the sound. In the forward torpedo room, a small trickle of water broke the waiting silence. The crew watched it without speaking. The flow stopped. "Condensation," observed someone.

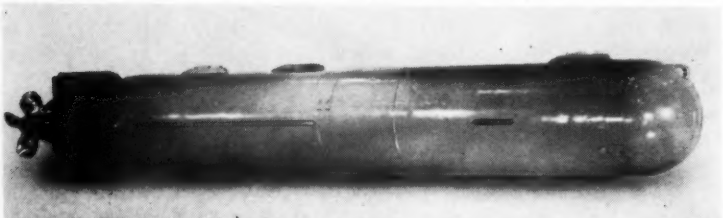
For two and one-half hours the men in the conning tower exerted all their skill, experience and ingenuity to outwit, outrun and outmaneuver the hunters. Above them, men in other control rooms and at their plotting boards tried equally hard to make a kill on *Dogfish*.

In the world above, men clutched rails and slid on slippery decks, tried to find their way safely onto the heaving deck of the carrier or search the ocean for their invisible quarry, but to the majority of *Dogfish's* crew, it was a state of Nirvana, punctuated only occasionally by that sharp rap on the hull.

One of the men remembered stowing away a case of his favorite apples and rummaged through the vegetable locker until he found them. In the messhall, the current movie was run through twice. When the crew had finished with it, it was passed on to the wardroom. In the aft torpedo room, the self-appointed ship's barber tried to catch up on his growing list of customers. Others not

Continued on page 35

SONAR SIGHTS—Acoustic homing torpedo finds it way with sonar device.



ANTISUBMARINE WARFARE today is one of the U. S. Navy's most important areas of responsibility for defense . . .

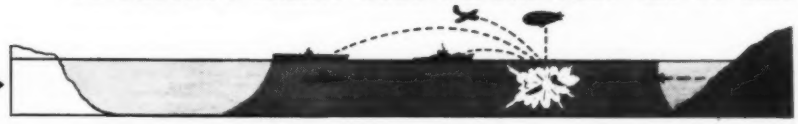
antisubmarine warfare falls into three phases

ASW

PHASE 1

TO DESTROY ENEMY SUBS BEFORE THEY GET TO SEA

PHASE 2



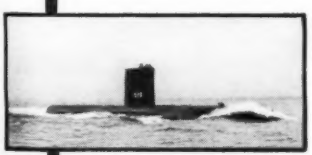
TO DESTROY ENEMY SUBS EN ROUTE TO THEIR TARGET

PHASE 3

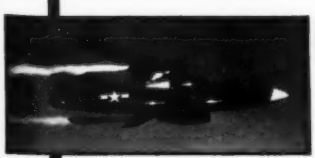
TO DESTROY ENEMY SUBS IN THEIR TARGET AREA

PHASE 1 TO DESTROY ENEMY SUBS BEFORE THEY GET TO SEA

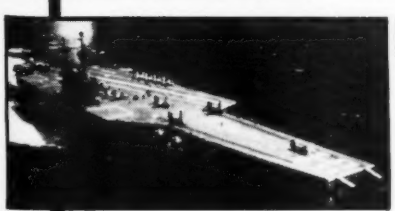
This job falls within the purview of the highly mobile attack carrier striking force, *Polaris*- and *Regulus*-launching subs, and long-range aircraft with mining capabilities.



The combination of the guided missile and the submarine gives the Navy a weapon of unprecedented stealth and secrecy. In relationship to Phase One of ASW, SSGs can be used to attack enemy submarines before they get to sea, and also attack their training, supply and support facilities. Other types of submarines will also be used to mine harbors and to attack enemy submarines and their tenders.



Mining enemy harbors is a vital phase of ASW. In addition to mine-laying submarines, our patrol aircraft and high performance carrier-based aircraft, such as the A3D *Skywarrior*, have important antisubmarine mining capabilities. New jet seaplanes are being built, capable of carrying up to 15 tons of mines and bombs, at high speeds and altitudes. Mines are offensive as well as defensive weapons.



The high speed and mobility of attack carrier striking forces provide the "Sunday punch" needed to strike at the very source of the enemy's submarine power. This force is built around new, powerful carriers that can launch longer range, faster planes with tremendous striking power, but supporting cruisers and destroyers—capable of firing guided missiles—have a vital role and are needed for a balanced striking force. Such a force can cover about 1,000 miles in a 24-hour period. Thus an enemy can never be sure where or when a carrier striking force will be at any given time. In the delivery of nuclear weapons, the Navy's attack carrier striking force supplements and enhances the striking power provided by other elements.

CVA Attack Aircraft Carrier

DD Destroyer

DDG Guided Missile Destroyer

DL Frigate

CAG Guided Missile Heavy Cruiser

CA Heavy Cruiser

SS Submarines

continued on next page

ASW continued from page 31

PHASE 2

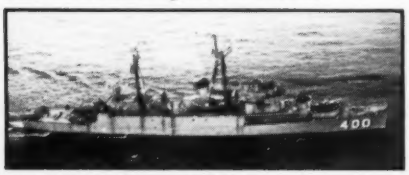
TO DESTROY ENEMY SUBS EN ROUTE TO THEIR TARGET

This is done through the coordinated efforts of Hunter-Killer Groups made up of a CVS with its fixed-wing aircraft and helicopters, and a number of DDs. Our own subs form barriers and also team-up with long-range patrol planes.

SHIPS AND PLANES THAT WATCH AROUND-THE-CLOCK FOR ENEMY SUBS

MSTS SHIPS and merchantmen provide our ASW forces with valuable intelligence on enemy submarine movements.

WV–2 SUPER CONNIES outfitted with a mass of electronics detection gear, extend our defenses against sub attacks.



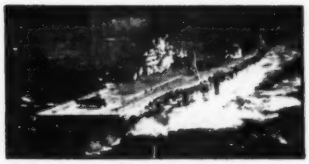
DERs—Although converted for radar picket duty, the former DEs maintain ASW punch and conduct submarine search.

P5M MARLINS, with the seas as their runway, form vital link in the Navy's highly versatile ASW detection team.

YAGRs: From their off-shore stations, these converted Liberty ships perform continuous advance warning duties.

Prepared by All Hands Magazine

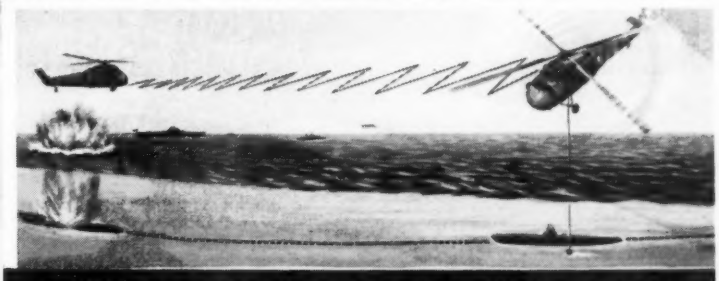
...t HUK Group;
...kill capability.



CVS carries the weapons to strike at enemy submarines.

P2V NEPTUNES are long-range shore-based ASW workhorses.

SUBS, alone or in team, can detect and kill enemy subs.



Two HSS–1s team up to box in enemy sub—as one picks him up with sonar ball, other moves in to deliver death blow of depth charge or torpedo. A single HSS–1 can carry equipment and weapons to do job by herself.

The HUK group consists of an ASW support carrier with fixed wing and HSS–1 rotary type aircraft and destroyer-type ships. These work as a team, seek subs in wide patterns around the surface ships. With HUK enemy forces, submarines are never out of range. S2F relays sonobuoy bearing to DD which depth charges enemy sub.

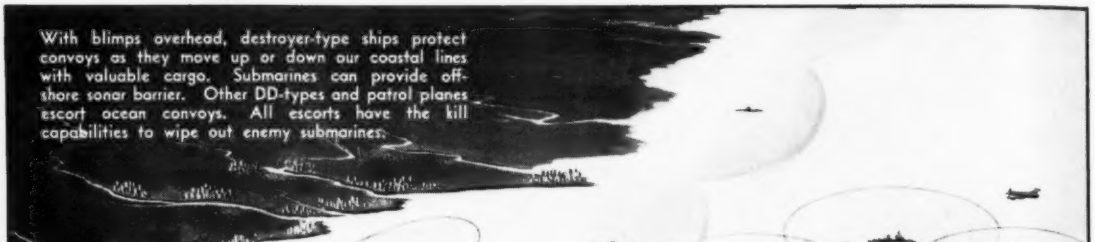
continued on next page

ASW continued from page 33

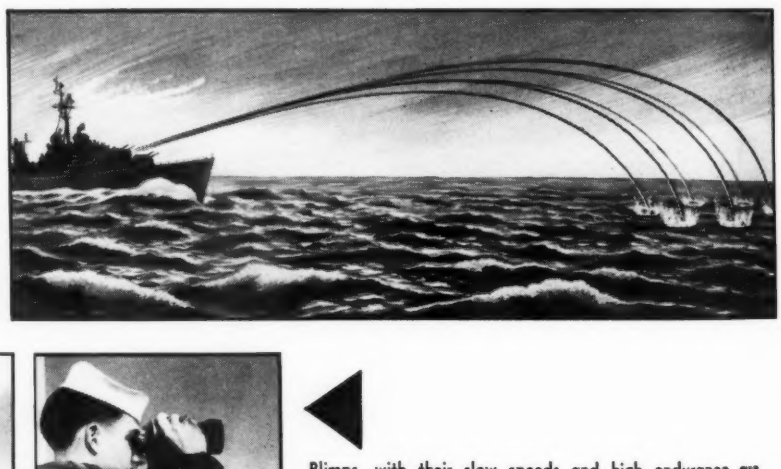
PHASE 3

TO DESTROY ENEMY SUBS IN THEIR TARGET AREA

Coastal and ocean convoys must be escorted and our own shores guarded in the event enemy subs get through to their target areas. Again HUK groups, SSs and DDs will team up with shore-based patrol planes and LTA craft for this task.



With blimps overhead, destroyer-type ships protect convoys as they move up or down our coastal lines with valuable cargo. Submarines can provide off-shore sonar barrier. Other DD-types and patrol planes escort ocean convoys. All escorts have the kill capabilities to wipe out enemy submarines.



Hedgehogs proved scourge to enemy subs in WW II. Sonarman holds contact with sub while ranges and bearings are converted to target's motion by fire control instruments. The mortar-type projectiles are fired electrically in groups of 24 charges. They must score a hit on a submarine to explode.

Blimps, with their slow speeds and high endurance are faster than the speediest of subs. They can tow submarine-detecting equipment at slow speeds to clamp a lid on enemy submarines. They carry all types of electronics detection gear, plus the ordnance to destroy the enemy's subs. Long before all this latest electronic gear came into being, the human eye was the main spotter of periscope feathers. Times have changed, but it's still the lookout who is ever important in antisub warfare.

WEAPON ABLE fires a 12.75 inch rocket with heavier bursting charge and range than hedgehog.

DETONATED DEPTH CHARGE from DE destroys subs by sharp shock wave of underwater explosion.

HOMING TORPEDOES, launched or dropped from ships and planes, track and sink subs.

on duty simply hit the sack. With no distinction between day and night, any time was sack time.

"ONE THING ABOUT THESE simulated exercises," commented Clark, "They're real easy on your back. You know what you characters would be doing if they were real? You'd be sweating your brains out trying to manhandle those fish where they'd do more good than taking up space in this sweatbox.

"I remember the time in Gitmo when we went through these exercises. Those lads were sharp. Didn't let you get away with a thing.

"Key West, too. By this time we'd have so many grenades on our hull you'd think they were playing the Anvil Chorus."

"They play rough out in Pearl."

Later, in the wardroom at lunch, one of the very junior officers enthusiastically summed up the morning's work: "Walked right through them! Started off the whole exercise by sinking their precious carrier and then gave her two cans to keep her company on the bottom."

The SOP grunted. "Son," he commented, "did it ever occur to you that the people topside might take a different view of things? Just remember, although we got three of their craft in our sights, it doesn't necessarily mean we sank them. And if we were playing for keeps, every one of those whaps we heard on the hull could mean real trouble."

THE PLOT FOR the afternoon was somewhat different. At 1300, *Dogfish* was to be at a point known only to the admiral and the boat's CO. It was up to the carrier's planes to take off at that time and find her. *Dogfish* was to dive and the planes were to hang on to her until the DDEs arrived, then transfer sonar coverage to them. For the first half-hour *Dogfish* was not to vary more than 30 degrees from her original course; after that time, she was permitted to take full evasive action.

Transference of *Dogfish's* blip on the sonar scope did not always proceed according to plan and on one occasion at least, she found it necessary to rise to the surface and wave her snorkel under the bows of the DDEs before they could resume their pursuit. Her only thanks were more grenades on her hull.

Exercises on the following day followed a similar type of pattern.

HUNTER AND HUNTED—*Tracker* comes in for landing on *USS Valley Forge* during break in sub search. *Below: USS Dogfish* heads out to play enemy.

As the exercises continued, the task force found itself working southward until, early Thursday the group found itself in the latitude of Norfolk. Meanwhile, one of the winter's worst blizzards along the eastern seaboard had translated itself into a full gale at sea.

As a result, upon orders from the admiral, the task force ran before the storm into nearby Norfolk and *Dogfish* began her 30-plus hour battle to New London with a 50-knot wind upon her starboard quarter.

She arrived at 1700 Friday, black smoke rolling from her No. 1 diesel. A large share of the crew had suffered bruises during the rolls of up to 50 degrees and Maynard J. Hall, SN, was in sick bay with a broken hand, received while standing lookout duty. Overtaking light, centerline antenna and topside sonar dome had been carried away.

Another routine training exercise had been completed.

THE HUNTED—Sonar on ships, submarines, and planes leads the way to the kill in battle against underwater enemies.

SONAR: SOUND SEEKS SUB

A HELICOPTER HOPPING across the ocean surface reports a _____ contact with a submarine. A destroyer-type vessel guided by _____ rushes toward the enemy SS. A fixed wing aircraft swoops low and drops a torpedo that will be guided to its target by a tiny _____ device while a friendly sub some distance away conducts a _____ search for other undersea intruders.

The missing word in each of these statements is *sonar*, the key that unlocks the door to successful antisubmarine warfare.

All Navy's antisubmarine elements, whether they move through the air, on the surface or in the ocean depths have one thing in common—SONAR sonic NAVIGATION and RANGING). This is the ear that gives "sight" through sound to the attacking force as well as the enemy sub.

Sink the destroyer, and the aircraft will continue the attack directed by sonar. Destroy the friendly submarine and the sonar guided surface and air units will continue the attack. But take away the sonar capabilities and the attack will end, for the hunters will no longer have the ability to detect a submerged submarine.

The enemy below will be able to move through the depths undetected without *his* sonar but, he too, will be blind. To fire his torpedo he must then expose his periscope to locate a target and when he does he will be sighted visually or by radar. Navigation beneath the surface will be nearly impossible and the effectiveness of the submarine reduced to almost nothing.

BUT WE *do* have sonar which gives submarines the ability to navigate under the polar icecaps, to cross oceans without surfacing, and to attack. And, what is more important, sonar is the principal means of finding an enemy submarine and bringing the instruments of destruction to it.

Sonar is the name applied to a complicated electronic device that can listen with super-sensitive ears to sounds originating under water (*passive sonar*) or can transmit a sound wave through the depths that will bounce back with an echo upon striking a solid object (*active sonar*).

Passive sonar is used most widely by submarines to enable them to detect objects making noise without themselves transmitting a tell-tale ping. The passive equipment could be compared with a live directional microphone sitting in the middle of a room. It would pick up sounds originating in the room and, because of the directional nature of the mike, would give a general bearing of the noise-making object.

This type of sonar achieved importance shortly after the submarine proved it was an economical means of inflicting damage on the enemy. Warships received hydrophone equipment to detect the approach of German U-boats during World War I.

This listening equipment could detect an enemy at considerable distance, but the attacking surface ship had to be dead in the water for the equipment to function. Once a general bearing was received the ship crept forward, stopping to listen again, and again, until in position for an attack.

One story that came out of the 1914-18 conflict indicates how sensitive hydrophones were 40 years ago. The ASW surface units heard over their hydrophone equipment a German sub breaking up and sinking after a depth bomb attack, and later heard pistol shots as the trapped submarine crew apparently committed suicide.

DURING WORLD WAR II German cruisers and submarines carried giant arrays of hydrophones used to detect approaching ships or even torpedoes. Today submarines still rely on supersensitive hydrophones

to listen for the enemy. One sub, USS *Flying Fish* (AGSS 229), carried an experimental hydrophone array measuring approximately 48 by 24 feet.

Active sonar or echo-ranging was in its infancy during the period of peace between World Wars I and II, but development went forward based on the principle that supersonic sound waves of high frequency (beyond audible range) can be transmitted through water and, on striking a solid object, are reflected and can be picked up by the same apparatus from which they emanated. This type of sonar can give the exact bearing and range of the object. The British called this ASDIC (named for the Anti-Submarine Defense Investigation Committee) while the U. S. applied the name SONAR to the device.

The first type of echo-ranging equipment worked like a searchlight. The transmitted sound beam or im-

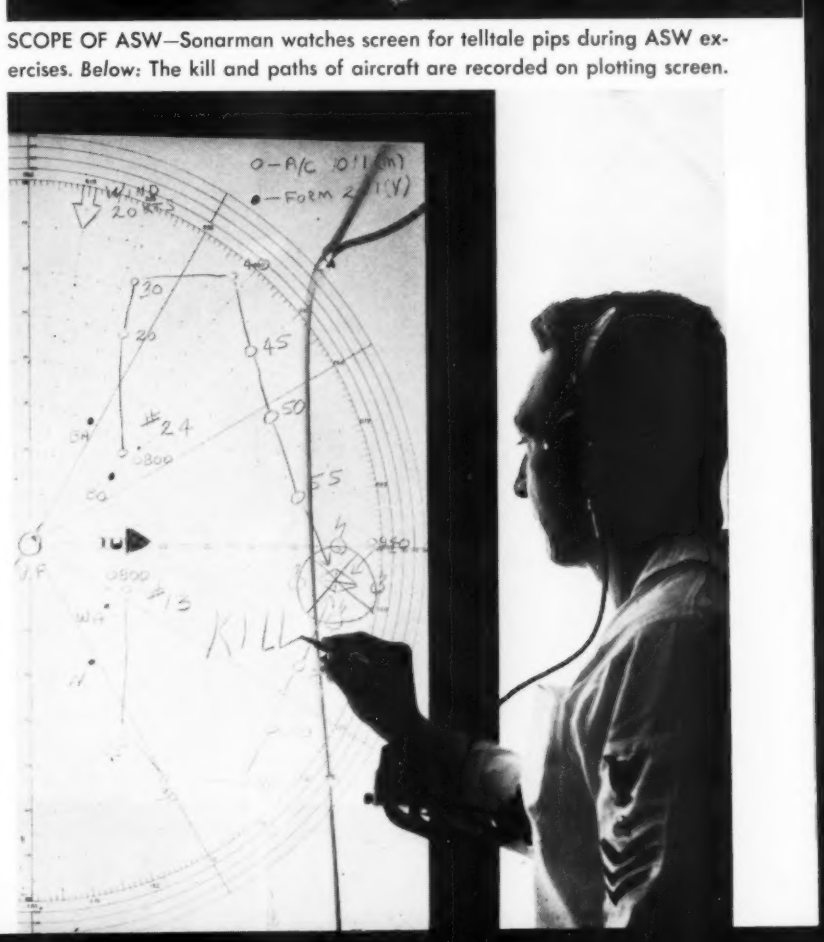
KSUBS

pulse, was only 15 to 20 degrees wide and objects on either side of the beam could escape detection. In order to counteract this, U. S. Navy yeomen, storekeepers or any one of the many rates that manned the sonar gear until 1943 when the sonarman rating was established, searched an intricate pattern by training the sonar beam in azimuth. During the months preceding 7 Dec 1941, the normal procedure for a sonar operator would be to start pinging on the starboard beam moving forward 10 degrees, back five, up 10 and so on until the equipment pinged five degrees past the bow. The search then swung to the port beam and came forward on the up 10, back five basis until it passed the bow.

Later this was changed to a straight five degree search pattern, but either way, a thorough underwater search was a slow step-by-step process. Today that has all been changed, owing to the new types of equipment developed by Navy scientists.

IN THE NEW TYPES of equipment termed *scanning sonar*, (we'll have to get rather technical here) the sound wave leaves the transducer (transmitting antenna) on the bottom of the hull and radiates over

SCOPE OF ASW—Sonarman watches screen for telltale pips during ASW exercises. *Below:* The kill and paths of aircraft are recorded on plotting screen.



FOR THE BIRDS—Whirlybird crew member operates antisubmarine sonar gear aboard helicopter especially designed for important role locating subs.

360 degrees. The returning echoes are pictured on a scope by pips much like radar reflections, but the echo can be heard on only one bearing. Each time the equipment transmits, a spoke of light, called the "audio channel indicating cursor" flashes on the scope, indicating the direction from which an echo can be heard.

This cursor can be trained manually or rotated 360 degrees automatically. When the cursor is trained on a pip, the echo caused by the object will be heard over a speaker or earphone and the range and bearing indicated on counters.

Research workers have also overcome the speed limitations on surface ships using echo-ranging equipment. During World War II the maximum speed possible for successful echo-ranging was about 22 knots. After that, the signal was drowned out by the water noises generated by your own ship.

Today echo-ranging can be successful at higher speeds.

To understand how all this works you must first understand sound. *Sound is the physical cause of the sensation of hearing.* It travels in the form of waves away from the point where the sound originates, just as ripples travel in all directions when a pebble is tossed in a pond. Sound waves travel in three dimensions only until they are interrupted by a strong air current or solid object, which causes the sound waves to rebound toward the source in the form of an echo.

Sound is passed along by the particles of the material through which it is traveling like a basketball is passed from player to player as the ball is moved down court. Remove the players and the ball cannot move; remove the particles and the sound will not move. Sound waves cannot be transmitted in a vacuum but they can, as we know, move through solid steel, a gas such as air, or as sonar proves, through water.

TO ILLUSTRATE HOW underwater sound works, imagine your ears to be sonar receivers and your mouth the transducer or transmitter antenna. If you stood on top of a mountain and yelled down into a valley you could find the approximate range by timing the number of seconds between your "hello" and the arrival of the "echo."

By multiplying half that time by the known speed of sound (approximately 1090 feet per second at 32 degrees F.) you would arrive at the range to the point where the echo began. The bearing, in this case, would be determined by the coordinated action of your ears. This is an example of active sonar or echo-ranging.

You use passive sonar every time you stop to determine the direction of a sound.

When you find the direction from which the sound is loudest you will know the bearing, but it will be nearly impossible to determine the range unless you can see the cause of the sound waves (such as lightning, smoke from a gun shot, etc.) and the time the sound passes from the source to your ear.

However, with modern hydrophone gear it is possible to determine the range to a target and its bearing with a high degree of accuracy.

You have heard of whistles, used to call dogs, that produce a noise beyond the audible range of the human ear. That is *ultrasonic* or *supersonic sound* (high tone). It is found in the range above 15,000 cycles per second. *Subsonic sound* (low tone) is below 20 cycles per second and the audible range is between the two.

In sonar we deal in ultrasonics.

If you stood beside the transducer that sends out the sonar ping you would not hear the sound, but as you listen at the sonar console you can hear the return echo because the gear has stepped it down from the transmitted 20 or 25.5 kilocycles to a usable 800 cycles.

This has been determined to be the most pleasant tone the human ear can be subjected to over extended periods of time.

LET'S TAKE A LOOK at what happens to a sonar impulse after it leaves the transducer beneath the ship. It will be moving at a rate of between 4700 to 5300 feet per second, depending on temperature, salinity and pressure of the water.

This is four or five times faster than the speed of sound in air, but the hazards of travel take their toll on this speed and the signal strength. Some of the sound will be absorbed by currents, bubbles or wakes and it will be further weakened by scattering as it passes through water full of foreign matter, i.e., seaweed, silt, animal life or air bubbles.

Also, like a searchlight beam, the sound wave will spread out as it travels farther and farther away

from the transducer and will thus become weaker.

Once it does strike an object such as a submarine, that portion of the impulse which is at a right angle to the object will be reflected back toward the sonar receiver. Again it will be acted upon by absorption, scattering and spreading, but a signal will be received indicating a possible target provided it is not drowned out by reverberations, self-noise, and "ambient noise level." These are multiple reflections or echoes which can come from many sources.

Sound waves bouncing off small objects such as fish or air bubbles produce small echoes. Sound reflected from the sea surface and bottom will also echo and the sea mass itself will cause still unexplained reverberations. These reverberations will come in over the audio receiver in the form of a roar. Reverberations from nearby points may be so loud that they interfere with or completely mask the returning echo from a target.

YOU READ EARLIER that the speed at which sound travels through the water is governed by *salinity*, *pressure* and *temperature*.

Salinity affects the speed of sound because salt water is denser than fresh water. If you key a sound beam into water which varies in salt content, the speed will rise and fall in direct relation to the salt content.

Water under *pressure* also speeds a sound wave because the particles through which sound moves are closer together. Therefore, if you ping straight down, the beam will increase in speed as the water pressure increases.

The high pressure found at lower depths tends to bend a sound beam up toward the lower pressure near the surface, and the *temperature* of the water will also bend the beam.

If you key a beam into water that is cool near the surface, but warm at lower depths, the beam will be bent up toward the surface, giving a very short range. Reverse the warm and cold layers and the beam will bend toward the bottom. A split beam can be caused by water that has a constant temperature layer near the surface and a colder layer near the bottom. A portion of the beam will refract (or split off) at the cold boundary and head for the bottom while the remainder will bend toward the ocean surface.

However, the ocean is usually fairly uniform in structure: first will come a surface layer with relatively uniform temperature; next will be the thermocline where the temperature will decrease rapidly, followed by the rest of the ocean which features a slowly decreasing temperature.

These various layers have a definite effect on sonar sound waves. Sub skippers who have dived through a sharp thermocline area have reported that the screw noises of the pursuing surface ship disappeared. Surface skippers report that ranges on submarines are greatly reduced when the sub dives below this area, and the echoes received are weak and mushy, if received at all. Later, we'll see how the sonarman learns of these changing conditions.

NOW LET'S TAKE A LOOK at the sound gear found on a typical ship or submarine.

The surface vessel is primarily a searcher and so makes extensive use of echo-ranging (active sonar); the submarine is concerned with hiding and uses passive sonar (listening) to avoid giving away its position with a tell-tale ping.

On the bottom of the hull of a surface ship is located the transducer which launches the sound waves into the water by converting the equipment's electrical energy into sound vibrations. (In the case of a submarine, the transducer may be located on top of the hull, below it, in the bow or in the sail.) Transmitter, amplifier, receiver-scanning assembly and signal data converter are all housed in large cabinets and connected together by a network of cables.

In front of the sonarman is the "console" panel from which he controls all of the *azimuth search sound gear*.

A short distance away will be the "console" for the *depth-finding* gear.

On the azimuth console we find: a *scope*, where the reflected echoes will be pictured; *range selector; pulse length selector* (controls length of signal transmitted); *cursor range knob* and other controls.

Speakers will be on the bulkheads and *azimuth-range indicators* are installed in the sonar system along with a *range rate recorder*. The latter device constantly records the range by burning a trace on a chemically treated paper.

The series of traces on the range rate recorder will give an operator the *rate of change of range* and will tell the moment to fire ASW weapons. The azimuth range indicator gives the *range to the point in the ocean occupied by the target*. This is called "slant range."

The depth sonar console generally includes the same equipment as found on the azimuth search rig, but supplies readings of the depth of the target by determining the angle of depression of the reflecting body. The depth gear normally uses the same sonar impulse as the azimuth search equipment and can be used for echo-ranging when not being used for depth determination.

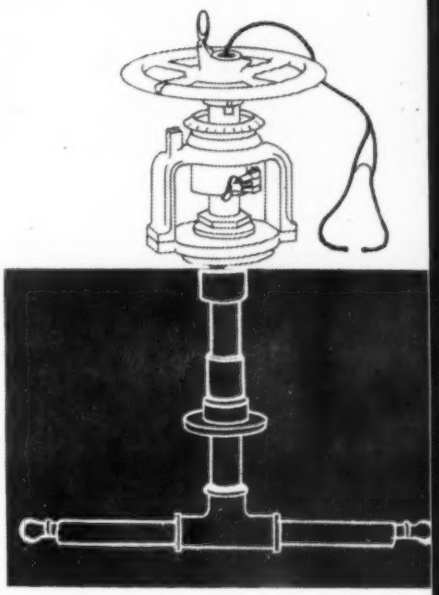
The azimuth search and depth units have settings for various range bands, and for listening.

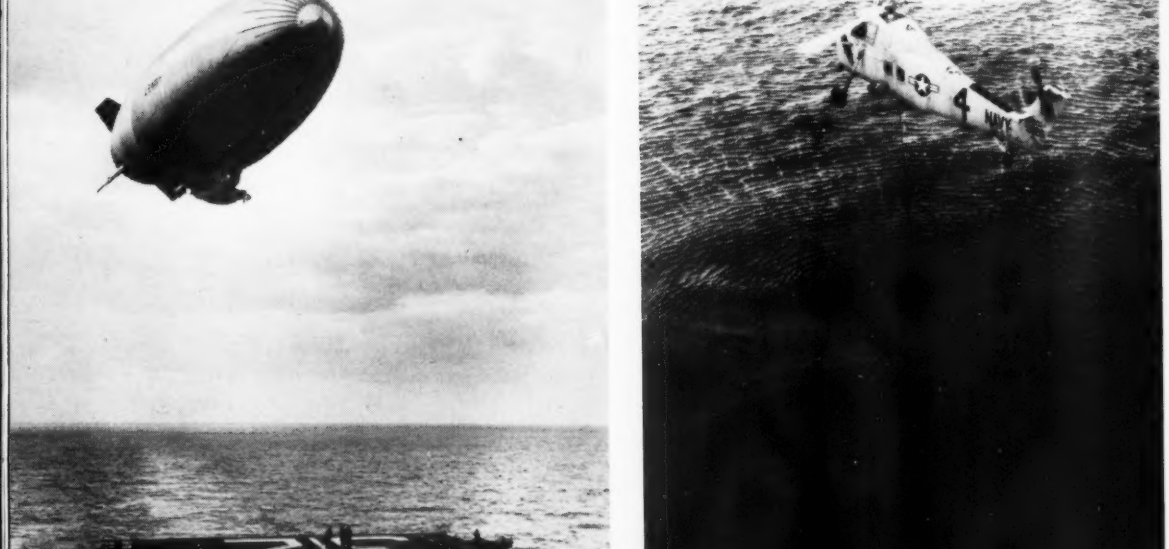
AS INFORMATION is received over the azimuth search and depth sonars, it must be correlated to give the ASW fire control officer the exact location of the target. This job falls to the *sonar computer-recorder*, a high speed electronic brain.

This brain takes the raw material fed to it as electric impulses by the search and depth sonar and combines it with information concerning the water temperature at various depths.

Once this material is digested it fixes the sub's position in *horizontal*

FORERUNNER of present-day sonar was the hydrophone used against German U-boat menace in WW I.





COMPACT UNITS of sonar have been developed for 'copters and blimps to probe the ocean, hovering near surface.

range (distance across surface to a point directly over the target), *bearing* and *depth*. This info goes into the underwater fire control system where antisubmarine weapons are brought to bear.

To obtain the information concerning the different water temperature layers, the sonarman streams a bathythermograph (BT) through the water at various depths.

When the small torpedo-shaped object, suspended on 1200 feet of cable, is brought back to the surface, the temperature at various levels has been recorded on a small glass slide by the thermal assembly. It can record temperatures to a depth of 900 feet on the smoked slides.

The BT is hoisted by an electric winch located near the stern on destroyers. On a submarine the water temperature determining equipment is mounted on the hull, and the outside temperature can be read inside the boat at any time.

SONAR SYSTEMS, such as the one described, come in mighty big packages for ships and submarines, but smaller and more simple units have been developed for helicopters and blimps and even smaller units for frogmen and the amphibious forces.

One type, the *sonobuoy*, was developed for aircraft that cannot dip a ball-shaped transducer into the water as can a helicopter or blimp.

These sonobuoys are buoyant tubes, each one containing a hydrophone and radio transmitter. They are dropped from an aircraft and the sounds that the hydrophones pick up are broadcast to surface craft or aircraft, each sonobuoy being on a slightly different frequency.

The sonobuoys are normally placed in a pattern over a suspected area by slow flying aircraft and, by comparing the different signals, the target can be pin-pointed. Under normal conditions they can detect a target at a distance of about 2000 yards, but under good conditions they have detected a sub proceeding at high speeds on diesels as far away as 10 miles.

The sonar equipment aboard a fixed-wing carrier-based aircraft is usually operated by one man, as is the helicopter and blimp sound gear. On the two slow flying vehicles, capable of hovering over one spot, a *ball-shaped transducer* is lowered into the water on a long cable. With this gear the helicopter or blimp can listen or echo-range. If a dip at one point produces negative results the ball is lifted clear and the aircraft moves to another point.

Sonar has also entered the weapons field. It can now be found in either active or passive form, encased in the hull of a homing torpedo. The active sonar torpedo pings for its target and, once on, the continued return of echoes will insure a kill. Passive torpedoes "home in" on the target's own noise.

HOW DO DESTROYER TYPE ships use sonar in an attack?

Just as soon as 'battle-stations' sounds, the normal steaming watch of two sonarmen will be increased to four or five. In the room next to the sonar shack additional underwater fire control stations will be manned.

A typical destroyer running ahead of a convoy or task force would normally conduct sonar search in areas assigned by the force commander, but for the purposes of illustration, let's assume a search on both sides of the bow.

The sonarman will first ping out on the beam and then move his cursor forward 10 degrees to key the next sound wave and so on to the bow where he will ping twice before starting on the other beam.

His routine will be *ping, train* to the next bearing and then *listen* for an echo.

All this time the sonarman will be concentrating on picking up the returning audio echo and will also be watching the scope for visual indication of a returning echo. If a pip appears the cursor will be swung

around onto the bearing of the suspicious object. If the returning echo indicates that the pip is a form of sea life or a natural underwater object, he will return to his searching on the bow, but if the contact is believed to be a sub he will report to the bridge, say, "Sonar contact, bearing one six zero, range one one hundred."

Now that contact has been made, the operator of the equipment will change his procedure to a *ping, listen* and then *train* method.

Using this system he will always be trained directly at the submarine as the echo comes back. He will continue to announce bearings while the range recorder operator gives the range figures. Another sonarman will be operating the depth gear and a supervisor will watch over the entire operation, assisting and classifying information.

The width of the target will be determined by using a system of right and left "cuts." As soon as an echo comes back the sonarman will train aft in five-degree steps until the echo disappears and then come forward in two and a half degree jumps until the echo reappears. The report goes up to the bridge, "Right or left cut, one seven zero."

WHILE THIS REPORT is still in the mill the echo ranging beam will be leaping forward in five-degree steps until the echo disappears. Reversing his field the operator will ping aft in smaller steps and when the echo once again appears the left or right cut bearing will be called to the bridge.

Next the operator will report the *doppler* effect of the target. If he gives an "up" doppler report it means the target has an element of motion toward the ship. This is indicated by an echo that has a higher tone than the outgoing impulse. A "down" doppler report indicates the target is moving away and the returning echo will have a lower tone than the outgoing transmission.

The doppler report will be accompanied by a description of the echo. If it is sharp and clear it will more than likely indicate that it is a beam or bow echo, but if the reflected sound is mushy it will indicate a stern cut where the wake is most pronounced.

Quite often it is necessary for the sonar operator to report "lost contact." He doesn't do this until four or five pings have had no results. As the report is called to the bridge he will begin to search forward and aft of the last bearing on which he had contact. If contact is still not regained he will swing the cursor to the stern and begin to search forward on the side where contact was lost.

If the contact was lost at short range, say during a depth-charge attack, he would attempt to regain contact after the center charge had been dropped and the ship had commenced a turn. The sonarman would set his equipment for a fixed search 45 degrees abaft the beam to the target side. Forty seconds later he would begin searching forward in 10-degree steps and then aft to the starting point and then back to the bow. After searching the area from 45 degrees abaft the beam to the bow he would switch his cursor around to the opposite side as the ship commenced the next turn, and follow the same general routine. If contact is not regained, the standard beam-to-beam search would begin.

However if a destroyer contact is lost our team of antisubmarine forces still will be able to regain it and ultimately destroy the enemy submarine. Among these forces will be the killer submarine, and inside the hull will be a sonarman guiding the boat toward an enemy. His sonar system will be used exclusively for listening as he seeks the sounds of an enemy sub.

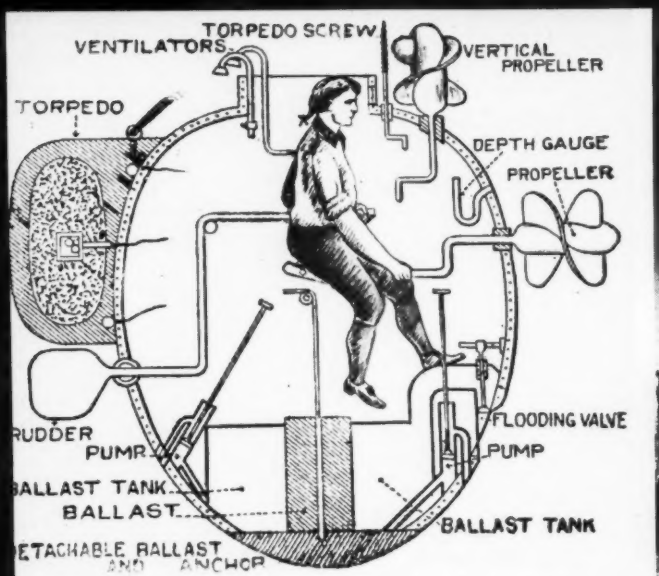
The submarine sonarman will use echo-ranging only for underwater navigation or possibly a single ping, launched now and then, to pinpoint a target. His ability to detect targets with supersensitive listening gear will enable HUK groups to launch aircraft for the attack while the underwater danger is still far away from his sub or the task force.

The submarine may join with sister boats to form a sound barrier through which enemy subs cannot pass without detection, but no matter what antisubmarine mission is assigned to a sub it will have to rely on its sonar "eyes" while seeking a target or fleeing from the enemy.

On the surface, ASW forces will be placing their hope of safeguarding the vital sea lanes, our coastal cities and our freedom from the invisible danger that strikes from below in the searching echo of sonar.

—William Prosser, JOC, USN.

FOR THE 'FISH'—Sonar gear aboard conventional and nuclear-powered subs gives them capabilities of tracking down enemy in its own environment.



'TURTLE' caused British to pull out of harbor. *Rt:* Mines and nets were laid against *Davids* in the Civil War.

Antisubmarine Warfare Date

MODERN ANTISUBMARINE WARFARE, carried on with nuclear depth charges, guided missiles and the latest in ships, aircraft and detection devices, is a grim battle between increasingly potent weapons and counter-weapons, with the balance of power see-sawing back and forth—first favoring one, then the other.

From a historical standpoint, however, the submarine (or at least underwater vessels) had a big head start, for attempts to build submersible craft date back several centuries before the birth of Christ, while there is little record of any sort of antisubmarine measure until the American Revolution.

The first recorded attempt to descend under the water in a vessel of any type occurred sometime between 356 and 323 B.C., when Alexander the Great reportedly had himself lowered into shallow ocean depths in a glass barrel so that he could make underwater observations. According to Aristotle, Alexander used similar vessels to repel a fleet that was attempting to lift the seige of Tyre. Herodotus (460 B.C.) and Pliny the elder (77 A.D.) also mention determined attempts to build submersibles.

Later on Leonardo da Vinci joined the experimenters. Two years before Columbus discovered America, da Vinci was dabbling in submarines, and he also studied underwater sound. In his scientific notes da Vinci wrote: "If you cause your ship to stop and place the head of a long tube in the water, and place the other extremity to your ear, you will hear ships at a great distance from you."

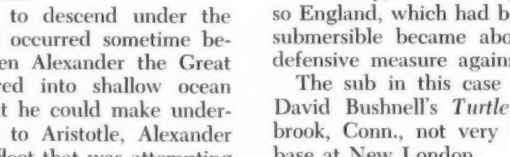
Along about the time the Pilgrims were landing at Plymouth Rock, Cornelius van Drebbel, a Dutch engineer in the English Navy, came up with (or went down with, if you prefer) the vessel generally considered the first true submersible. This so-called "eel boat" was essentially a leather-covered rowboat, large enough to contain several hours' supply of air. It was propelled by 12 oarsmen whose oars projected through watertight leather seals. The king of England is said to have ridden in this craft when it traveled from Westminster to Greenwich 15 feet below the surface of the Thames.

EVIDENTLY, NAVAL AUTHORITIES weren't very impressed with van Drebbel's brainchild, since another 156 years elapsed before anyone took a submersible into actual combat for purposes of sinking an enemy ship.

Ironically, a British ship was the target of this attack, so England, which had been credited with the first true submersible became about the first nation to take a defensive measure against one.

The sub in this case was, of course, the American David Bushnell's *Turtle*, completed in 1776 at Saybrook, Conn., not very far from the present-day sub base at New London.

Shaped like an egg on end, *Turtle* carried a one-man crew and was designed for attaching torpedoes to ship bottoms. Her maiden foray, against HMS *Eagle* wasn't exactly a rousing success, since the screw for attaching the torpedo wasn't sharp enough to penetrate the English ship's copper bottom. However, Bushnell's sortie did inspire a defensive antisubmarine measure—evasion, or "getting the heck out of there." In other words, to avoid future attacks the British moved their blockading ships from the harbor to the outer bay.



USS Holland — 1900

After that came more experiments with subs, including some by Robert Fulton, who tried to sell the French on a submarine to sink English shipping and—when France wouldn't buy—to sell the English on one to sink French ships. As part of his

DEPTH CHARGES are readied in WW I fight against U-boats. *Rt:* German sub caught by PB4Y *Liberator* in WW II.

Back to American Revolution

sales pitch Fulton gave a demonstration in which he blew up a brig in the Thames.

STILL, LITTLE MORE was heard of antisubmarine warfare until the Civil War. In that conflict both the Union and Confederate navies worked on diving torpedo boats and Navymen began to take them a little more seriously.

The Union program didn't get very far. One Federal "sub," *Alligator,* sank in a storm off Hampton Roads before she had a chance to see action and another, *Intelligent Whale,* never got beyond the experimental stage.

The Confederate effort was more determined, since the South didn't have much of a fleet and was willing to take chances in the search to find ways of offsetting the Union's naval strength. Often, this desperate gamble cost the lives of heroic men who volunteered for the hazardous duty in the Confederate craft.

The center of the South's submarine activity was Charleston, S. C., and the Union blockading squadron there was on the alert for possible torpedo attacks. However, on the night of 5 Oct 1863, when one of the *Davids* (Confederate torpedo boats which operated in a semi-submerged position) set out to explode a spar torpedo against the steamer USS *New Ironsides,* the ironclad's chief defense was merely the musketry of her Marine sentries. The *David's* skipper returned the fire with a shotgun, picking off the Federal ship's officer of the deck while the sub bore on to set off her torpedo. In the resultant blast the Federal ship suffered no major damage, but the *David* was so shaken up that she barely got back to her base.

Following this attack the blockading squadron took further anti-David precautions. Lookouts were doubled, steam was kept up, anchors were made ready to slip, picket boats and steam tugs patrolled at night and booms and nets were rigged wherever possible.

These measures weren't enough to stop *Hunley,* which was designed for total submersion in the style of latter-day submarines. She had gone down five times, carrying 41 men to watery graves before she ever saw action, so she was about due for a break when she finally got one on 17 Feb 1864.

That night she became the first submarine in history to sink an enemy ship under actual combat conditions.

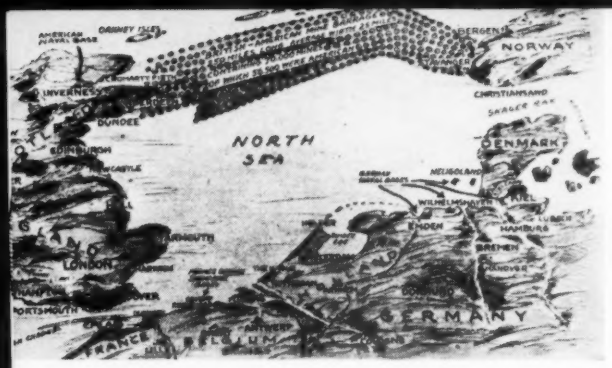
Simultaneously, she ran into more bad luck. She had made her attack in an "awash" position, but in her moment of triumph she took her sixth and last one-way dive, adding six more names to the Confederate casualty lists.

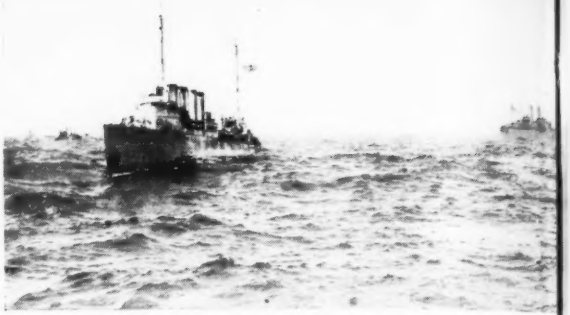
Hunley's victim was USS *Housatonic,* which tried to stop the sub with musket fire and made a belated attempt at evasion. (See ALL HANDS special supplement, p. 59, April 1956.)

AFTER THE CIVIL WAR the navies of most major nations began to show more interest in submarines and methods of combating them. By the 1890's the American inventors John P. Holland and Simon Lake had been working on underwater warships for quite a while. Nordenfelt in Sweden, and Zede and Romazzotti in France were building submarines and Russia and Germany were also active in the field.

Antisubmarine warfare at this stage of the race was lagging behind, for the difficulties involved in fighting this new menace were not fully realized—as witness this excerpt from the 1903 edition of *Jane's:*

USS Skipjack, SS(N) 585 — 1958





NORTH SEA mine barrier bottled up U-boats in WW I. *Rt:* Jan 1917 U. S. Destroyers join British ships in sub battle.

"*Other Means of Fighting Submarines:*

"... To explode charges over her is therefore very easy, but an even simpler mode of attack exists. With a few picket boats out nothing should be simpler than to catch hold of a periscope. Then one of two things will happen: either the boat will be brought up all standing and captured; or else the periscope will be wrenched out of her, with the result that she will be in imminent danger of sinking. She will then have to come to the surface, and probably be captured or destroyed without much trouble."

WHEN WORLD WAR I exploded in Europe, Germany soon made it plain that it would take a lot more than periscope grabbing to stop the *unterseeboot*.

On 8 Aug 1914, two days after the outbreak of hostilities, a German sub attacked the British battleship *Monarch* with the first mobile submarine torpedoes ever fired at an enemy warship.

That attack failed, but on 5 September another submarine sank the scout cruiser, HMS *Pathfinder,* and on the 22nd, three British heavy cruisers, *Aboukir, Cressy* and *Hogue,* were all sunk by a single submarine within one hour. The cargo steamer, *Glitra,* stopped, searched and scuttled on 20 October, was the first merchant ship to fall victim to the U-boats.

Naval warfare had entered a new dimension.

In the words of *Naval Orientation,* "The English countered with mines, Q-boat 'decoys' and a barrage of moral indignation. This last proved particularly effective, for it succeeded in branding the U-boat as the 'serpent of the sea' and helped to turn American opinion against the German war effort when the U-boat went all-out as a commerce raider."

At first, the weight of world opinion caused Germany to place some limitations on her undersea warfare, but even so, England was in grave difficulty. Antisubmarine mines, nets and underwater traps were not very effective, nor were Q-boats. These ships, carrying concealed deck guns and manned by highly trained crews, masqueraded as cargo ships or fishing trawlers with the hope that they could lure U-boats into making surface attacks. The Germans soon wised up to this stratagem and, as a result, the submarines sunk by such decoys numbered only 13 during the entire war.

HOWEVER THERE WAS some progress. England detailed destroyers and aircraft to the U-boat hunt, and in 1916 the hydrophone and depth charges went into action.

These measures, together with the arming of merchant ships, put a strain on the German submariner's morale and to some extent forced the U-boats to forego surface running and to operate with more caution. Such defensive ASW measures as zigzagging, blackout and steaming at high speed also did some good.

On 1 Jan 1917 Germany defied American reprisal and swept aside the restrictions on her submarine warfare. That April the United States entered the war and the U-boats, powerful though they were, found themselves unable to stop the overwhelming flow of American shipping, backed by American resources and escorted by the U. S. Navy.

In May 1917, with the dispatch of six DDs to Queenstown, Ireland, to join the British antisub patrols, American countermeasures began. Our destroyers were well equipped with depth charges to be launched from stern racks or thrown from "Y" guns.

In home waters a "mosquito fleet" of fast, agile subchasers was organized. But the chief American contribution to the antisubmarine war was the convoy system, instituted largely at the insistence of Admiral William S. Sims. From April to October 1917, only 10 of the 1501 ships in convoy were lost to submarines.

Other aids in countering the Germans were evasive routing, a wireless warning system and the trailing of U-boat movements through intelligence operations. Navy aircraft, with 27 bases in Europe, inaugurated an active U-boat hunt and also saw some action in raids on submarine pens.

ANOTHER VERY EFFECTIVE antisubmarine measure was the North Sea Mine Barrage, a 230-mile field which was made up of about 70,000 Mark H mines by the time the war ended.

Equipped with long antennas which extended in the water like tentacles, these electric mines were designed to go off when metal came in contact with one of the antennas. (See pp. 59-63 of the March 1953 issue of ALL HANDS.)

By October 1918, some 17 U-boats were sunk or damaged by the great mine barrier and at least 40 were missing, cause unknown. At Wilhelmshaven the German submariners mutinied and the mutiny spread to the High Seas Fleet at Kiel. The Germans had lost the undersea war—but in the process they had sunk more than 11 million tons of Allied and neutral shipping.

During the years between World Wars I and II, ASW gained some valuable new tools with the development of radar and sonar. The latter was first installed experimentally on USS *Rathburne* (DD 113), *Waters* (DD 115), *Talbot* (DD 114) and *Dent* (APD 9) in 1934.

There also were some changes in underwater armor and compartmentation to offer better protection against torpedoes, improvements in depth charges and bombs and such tactical advances as the establishment of antisubmarine patrols.

Meanwhile the submarine and submarine tactics were being improved too, especially by Germany.

IN THE FIRST MONTHS after World War II began in Europe (September 1939) it *seemed* as if the submarine had become much less a menace than it had been in World War I. (In January 1940 only two British ships were sunk by subs.)

Such revivals as the convoy system, the arming of merchant ships, the use of air patrols, and the bombing of sub bases and production facilities, plus the employment of new or improved devices for detecting and destroying subs were being given most of the credit.

However, when Germany put her submarine warfare into high gear after the fall of France in June 1940, the situation changed radically. Between 1 Jun 40 and 30 Jun 1941 close to 1400 British ships were lost to the underwater raiders.

The Battle of the Atlantic was on in earnest, and even with the pre-Pearl Harbor assistance of the U. S. Navy, England was being pressed hard.

In its early stages the battle was mostly a defensive one on the part of the Allies, who relied heavily on the convoy system and evasive routing. The Germans countered with "wolf-pack" tactics, in which their U-boats were spread out over a large area in order to detect convoys, then grouped together to make their attacks. Meanwhile, the Allies were trying to build merchant ships faster than the Germans could sink them and to produce escort ships and patrol planes in numbers that would be able to cope with the growing German submarine fleet. In addition, convoy systems were being improved and the American ASW effort was being reorganized for greater efficiency.

To an important degree, the Battle of the Atlantic depended on scientists and technicians who waged a see-saw war of gadgets.

For instance, when the Germans came up with an acoustic torpedo which homed on the noise made by a ship, the Allies quickly turned out noise-making "foxer" gear which could be towed behind a ship to divert the torpedo from its target.

When the Germans came up with search receivers to spot the approach of U-boat-hunting ships and planes equipped with meter-wave radar the Allies countered with the development of micro-wave or "S-band" radar.

AMONG THE OTHER developments were ahead-thrown ASW weapons like the "hedgehog" and "mousetrap," rockets to make aircraft more effective in attacks on submarines, the sonobuoy, increases in the detection capability of aircraft, and the entrance of the blimp into the ASW picture.

New ship types were also evolved, and especially important along this line were the CVE and DE, both of which could be turned out in considerable quantity because of their small size and simplified design.

The DE was a big factor in overcoming the shortage of escort vessels which plagued convoy operations during the early part of the war.

PCs AND TBFs hunt for subs off Florida coast in '43.

The CVE made it possible to furnish aerial cover to convoys for the entire length of their voyages and eventually, when there were enough of them in commission, they enabled the Navy to take the offensive against the subs through hunter-killer groups composed of the "baby flat-tops," DEs and DDs.

The German underwater fleet reached its peak in 1942, when it sent 8,245,000 tons of Allied shipping to the bottom while losing only 85 subs.

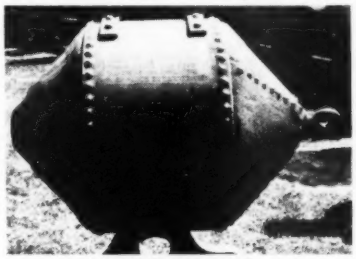
The following year, when ASW was at last able to undertake a real offensive, there was a sharp reversal in the figures. Ship sinkings dropped to 3,619,000 tons and the number of U-boat kills leaped to 237. The next year the number of U-boat kills rose to 241, while shipping losses took a drop—down to 1,422,000 tons.

In 1945, when the Germans made a last, desperate stand, the effort cost them 153 submarines in just four months—a figure which surpassed the total for the four war months of 1939 plus years of 1940, '41 and '42.

ALTHOUGH German U-boats had been defeated in World War II, the submarine still remained a formidable foe. The *schnorkel*-equipped Type 26 submarines, which Germany was working on when the war ended, could have made a big difference if they had gotten into action in time and in sufficient numbers. Possessed of great speed and maneuverability, and able to perform all their operations underwater, they were grim-voiced harbingers of things to come—things such as nuclear power and the *Albacore* hull.

These developments, plus the introduction of guided missiles to submarine armament, have made ASW planners keenly aware that the race between sub and antisub is far from over.

Thus, in the post-war years the Navy has made some important changes in its ASW lineup. Among them are such developments as the nuclear depth bomb, Weapon Able, the antisubmarine guided missile, the homing torpedo, MAD and ECM gear, improved ships and planes, the introduction of the helicopter and the increased use of submarines as killers of their own kind.



Confederate torpedo

Will these items and their successors master the submarine menace?

The answer to that question—if it has to be answered—will depend on the men in ASW.

—Jerry Wolff.

A NAVY BLIMP with hovering ability and great endurance is an ASW weapon that subs find hard to shake.

A Stable Platform for ASW

IN MARCH 1957 a Navy airship departed NAS South Weymouth, Mass., and 11 days later set down at Key West, Fla. Despite claims of the irreverent that 11 days was about par for the trip for blimps, this particular craft (known to its crew as "Whitey the Snowbird") had made a considerable detour.

The Key West landing marked the end of a flight in which Whitey's 14-man crew flew for 264 hours to set a world record for continuous non-refueled flight. Whitey had traveled from South Weymouth to the coast of Portugal, down the west coast of Africa and then, in the vicinity of the Cape Verde Islands, headed back across the Atlantic to land finally at Key West.

The trip was the culmination of a series of tests to demonstrate the reliability and endurance of the airship. Earlier in the year, five airships had manned an AEW station in the Atlantic off the New England coast continuously for 10 consecutive days. Weather was the worst in years with icing, snow, sleet, rain, fog and 60-knot winds. These blimps had relieved each other on station during a period when weather had grounded other types of military and commercial aircraft. One airship flew in continuous icing for 32 hours during a 40-hour patrol; another was airborne for 56 hours continuously. Landings and takeoffs were made with ceilings under 100 feet during snowstorms, and with winds from 30 to 50 knots.

These flights have helped to demonstrate the unique effectiveness of lighter-than-air craft in certain aspects of modern ASW and also in AEW.

BIG OPERATOR—Lighter-than-air craft can carry tons of sonar gear and airborne detection equipment. Here, blimp passes *USS Albacore* (AGSS 569).

Despite its relative lack of speed, and its vulnerability to attack, the blimp has no peer in its combined stability, load-carrying ability and endurance. It can carry tons of sonar gear and airborne detection equipment. It is a stable platform for electronics equipment. It can carry a large enough crew in relative comfort so that fatigue does not become a problem. It is much cheaper to operate than similarly equipped aircraft. Its endurance is traditional. New techniques in refueling, replenishment and remanning, while airborne, from carriers, tankers or supply ships make it possible for airships to range far over the ocean and accompany convoys and task forces over indefinite ranges.

To compare the lighter-than-air craft of today with the rigid dirigibles which became so well known in the '20s is no more reasonable than

a comparison of the Seamaster with the NC seaplanes of 1919.

The ZPG-2, used primarily as an ASW weapon, is some 340 feet long with a height of 100 feet. It is powered by two 800-horsepower engines mounted inside the cabin to give it a speed of 65-75 knots. Actual propulsion is achieved by two propellers mounted on outriggers projecting from each side of the car.

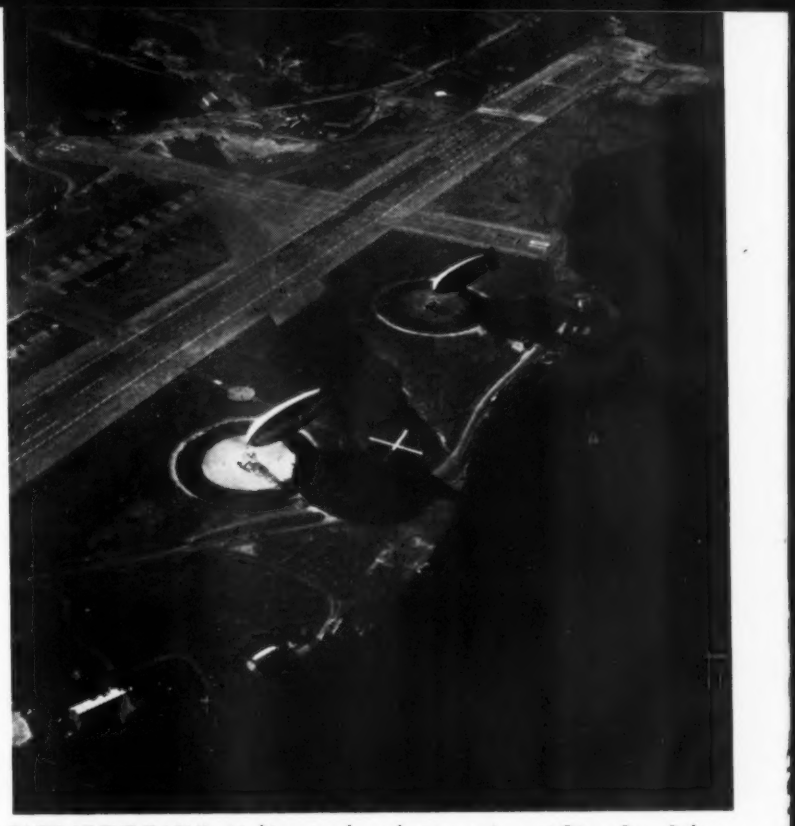
The control car, which is approximately 85 feet in length, is a double-decker with crew quarters (including nine bunks) and a galley above, and all the operational stations below.

Lighter-than-air men claim that the blimp, with its ability to hover and carry more and larger types of detection equipment is superior in spotting and warning.

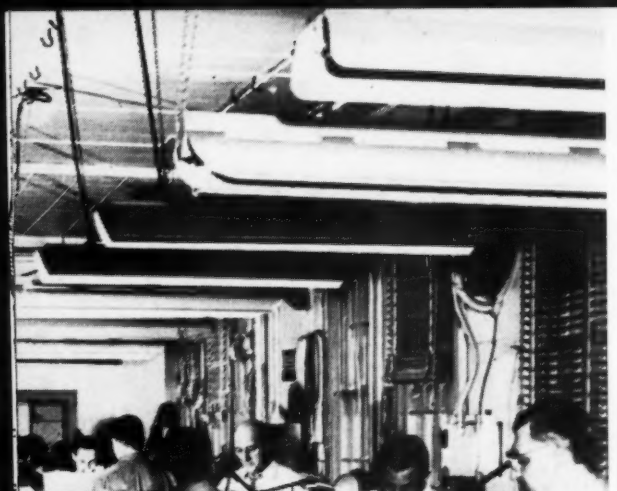
Some submariners are inclined to agree with them. "Planes, destroyers and helicopters are just the normal occupational hazards of our trade," observes LTJG Paul M. Pyper, of uss *Dogfish* (SS 350). "But once one of those fellows pins you down, he can stay with you until the end of time. A DD might make so much noise that it can't hear you, but you can hear it. Unless a plane can be relieved while he's on station above you, he's got to go home and gas up after a few hours. Same thing with a chopper. But when a blimp gets on you, he just sits and sits and sits, until finally you're forced to the surface. Then he clobbers you. That's only true with a conventional sub, of course."

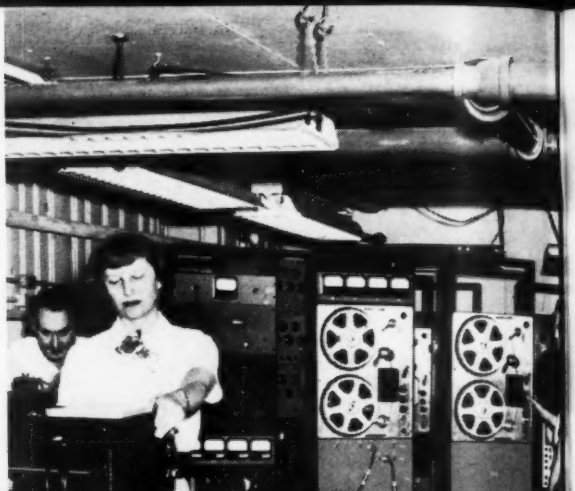
There are two ASW airship squadrons in the Atlantic Fleet today. One operates ZPG-2 airships out of Lakehurst and the other flies ZS2G models out of Glynco, Ga. Both models are equipped with the latest in electronics detection, localization and attack equipment. They have a bewildering variety of sonar devices, magnetic airborne detection gear, carry homing torpedoes or nuclear depth charges, and the longest range, most powerful radar carried in any aircraft today.

Blimps are used as convoy escorts, with hunter killer forces and in MAD and sonar barriers. Their ability to maintain contact with the submarine, once gained, and their capability through airborne CIC, of directing other forces, both surface and airborne, in for the kill, are their basic advantages. Their lack of speed and flexibility in pressing home an attack are their disadvantages.



BACK AT THE 'BARN'—Airships stand ready at moorings at Gitmo Bay. *Below:* Navymen at Lakehurst NAS give a ZPG blimp a protective coat of plastic paint.





NOW HEAR THIS—USL personnel work in labs and shops at sea and ashore to develop new ways of detecting subs.

Underwater Sound Laboratory

● DEADLY mines . . .

• Accurate, long-range homing torpedoes . . .

• Guided missiles with atomic warheads . . .

• High-speed, nuclear-powered submarines . . .

The U. S. Navy has all of these scientific weapons of modern warfare plus many, many more. But put them in the hands of an enemy submarine force and our control of the seas and national security are threatened.

In order to counter such a threat, the U. S. Navy must employ newer and better scientific antisubmarine weapons. Today, such weapons are not even developed—and a scientific "breakthrough" is required before they are. And it is from the nation's scientific laboratories that this "breakthrough" and new ASW weapons must come.

Typical of the Navy's many research and development activities on which this burden falls is the U. S. Navy Underwater Sound Laboratory at New London, Connecticut.

Commonly known as USL, the Underwater Sound Laboratory is proud to be referred to as "your underseas warfare electronics laboratory." It is administered by the Bureau of Ships, one of the three material bureaus in the Navy responsible for vital segments of research, engineering development and equipment procurement required for antisubmarine warfare.

THE BUREAUS of Ordnance, Aeronautics, and Ships, each have extensive contracts with civilian industry for the construction of new equipment and each of them have under their technical control several development laboratories. USL is one of them. It is the major concern of USL and the other related laboratories throughout the naval establishment to make all possible technical preparations to meet any threat from enemy submarines. Here's how the laboratories under the control of the different bureaus fit into the Navy's ASW picture:

• BUORD is chiefly concerned with the development and procurement of tracking equipment, fire control devices and weapons for making the final kill.

• BUAER has the responsibility for development of devices operated from planes, blimps and helicopters.

• BUSHIPS has the job of developing in its laboratories a wide range of devices for submarine search, detection and tracking, as well as related problems of communications, navigation and target identification.

USL is but one of many facilities under the control of BuShips to be heavily engaged in research and development of sonar and related underwater sound systems. Another is the Navy Electronics Laboratory at San Diego.

And, of course, there's the vital Naval Research Laboratory in Washington, D. C. (which is not a BuShips activity).

LET'S TAKE A CLOSER look at the Underwater Sound Laboratory (security permitting) and see just what an activity of this type consists of.

Basically, USL is many things—bricks and mortar; instruments; a climate for the exploration of natural forces by scientifically and technically trained people. But more than these, USL has its being in the vigor, determination and achievements of its staff.

THE STAFF AT USL is unique. It's made up of about 50 Navymen (15 officers and 35 enlisted men) and approximately 675 civilians. Coming from all walks of life, they include —to name but a few—oceanographers, electronics scientists, mathematicians, physicists, chemists, illustrators; mechanical, electrical and marine engineers, and technicians.

They are men who know the Navy, its ships, personnel, material and tactics. In a sense, the staff of USL is composed of a number of seagoing scientists—they spend approximately 40,000 man-hours per year aboard all types of naval ships in order to conduct engineering evaluations and to obtain new research data essential to the laboratory's scientific program.

USL's staff consists of dedicated men who have pioneered in the physics of sound in the sea, and in the applications of sonar and radio engineering to the unique requirements of underseas warfare. The field of underseas warfare electronics is unquestionably a unique field because it lacks any extensive commercial significance. Few are interested in the commercial possibilities of such specialized equipment as sonar, underwater telephones, passive noise detectors, torpedo defense, and mine location. Such things are used in quantity only by the Navy.

Commanding officer and director of the Underwater Sound Laboratory is Captain T. E. Ruble, USN, who assumed command in May 1956. A qualified submariner, he has been associated with various research projects dealing with special submarine weapons and underwater sound during a large portion of his 29 years of naval service.

Dr. John M. Ide is the Technical Director of Research at USL. He has served in that capacity since 1945. A noted scientist and inventor, Dr. Ide has been active in scientific research for more than 25 years. He joined the Sound Division of the Naval Research Laboratory in 1941 in order to engage in work directly related to national defense.

During the period 1941-45, Dr. Ide was responsible for the development of underwater loudspeakers, ultrasonic echo-ranging equipment, low-frequency acoustic minesweeping devices, and small-scale telephony and homing equipment for use by small craft and commando swimmers. As a result, Dr. Ide was awarded the first Meritorious Civilian Service Award given at the Naval Research Laboratory.

It is upon men like Dr. Ide and CAPT Ruble, and those working under their direction, that this country is depending for that scientific breakthrough needed if the U. S. Navy expects to control the seas and provide continental defense.

THE UNDERWATER SOUND Laboratory is situated in the heart of the city of New London. It is located at Fort Trumbull, a point of land which comprises some 25 acres jutting into the mouth of the Thames River.

Fort Trumbull is a military reservation with a history dating back to the Revolutionary War. It is of interest to note that one of this country's first antisubmarine experimental stations was organized on that site during World War I. At that initial research facility practical sonic detection devices were developed for installation on submarine chasers and destroyers.

On 1 Jul 1941, the Secretary of the Navy approved the establishment of the Underwater Sound Laboratory at Fort Trumbull. The Laboratory at that time was administered under an Office of Scientific Research and Development Contract with Columbia University and was known as the Columbia University Division of War Research.

Major consideration in the decision to locate the Laboratory at New London has an important bearing on its scientific program. USL is situated just about equal distance from New York and Boston where many of the nation's major research centers and manufacturing industries are located. Harvard, Brown, Yale, Columbia, Cornell, MIT, Penn State, and Woods Hole Oceanographic Institute are among the nearby activities engaged in underwater electronic research. USL takes full advantage of the opportunities offered for "cross fertilization" through the sharing of ideas, information, records, and techniques with these activities.

The Sound Lab also has the advantage of dock space for experimental vessels (see page 51) and the proximity to the headquarters of the Commander, Submarine Force, U. S. Atlantic Fleet and the U. S. Naval Submarine Base which activities are located just four miles up the Thames River. Then there's the principal commercial submarine building yard located across the river.

USL's riverside location provides

MANY SKILLS are used by scientists and technicians of USL to create and test gear to bring us nearer scientific 'breakthrough' needed for ASW weapons.

STRANGE CRAFT—Test barge for sonar antenna is located on nearby pond where water is clear and almost free of interfering noises.

easy access to submarine operating areas in the Long Island Sound and facilitates shipboard tests, measurements, and evaluations of equipment and systems. In addition, the wide variety of water and weather conditions encountered within a short steaming distance of New London permits the operation of equipment under a diversity of environmental conditions.

Columbia University operated the Laboratory throughout World War II, completing a number of important technical developments which contributed to the final victory.

IN MARCH 1945, the Laboratory was reorganized and put on a permanent peacetime basis. At that time the sonar development phase of the Harvard University Underwater Sound Laboratory was moved from Cambridge, Mass., to New London, and personnel, equipment, and portions of the research programs of both laboratories were consolidated under the technical direction of the Naval Research Laboratory. Just one year later, NRL relinquished its administrative responsibility to the Bureau of Ships, under whose management and technical control the Laboratory now operates.

The Underwater Sound Laboratory occupies 11 major and numerous minor buildings at Fort Trumbull. Facilities located there include a sound recording laboratory equipped with recording, reproducing and analyzing instruments; the Navy's only environmental test laboratory in the New England area equipped to test and evaluate electronics equipment manufactured for the Fleet; a computing laboratory containing an integrated data analysis unit for processing data recorded at sea; and well-instrumented shops for production of experimental models of electronic and mechanical devices.

In addition to the facilities at Fort Trumbull, USL also maintains two nearby field stations. One of them is an Underwater Acoustical Measurement Facility at Dodge Pond, in the town of Niantic, just six miles away. The other is a 75-acre tract on Fishers Island, N. Y., which is located about six miles out in Long Island Sound.

At Dodge Pond, USL maintains an elaborate test barge for the measurement and calibration of transducers (sonar antenna — see page 39) under precise conditions. It is located 300 feet out in the pond where the water is clean and almost noise-free, and the mud bottom 48 feet down prevents unwanted sound reflections. Facilities are available there for handling transducers weighing up to six and one-half tons.

The Sound Lab's Fishers Island Annex has the dual advantage of a commanding view of the submarine operating areas and a line-of-sight path to the Laboratory. It is an ideal location from which field tests may be conducted with submarines, surface vessels and aircraft. Standard radio, radar and signal light equipments have been installed for use during such tests. In addition, infrared communication and detection devices have been placed in operation for use as standard instrumentation in carrying out tests of infrared equipment.

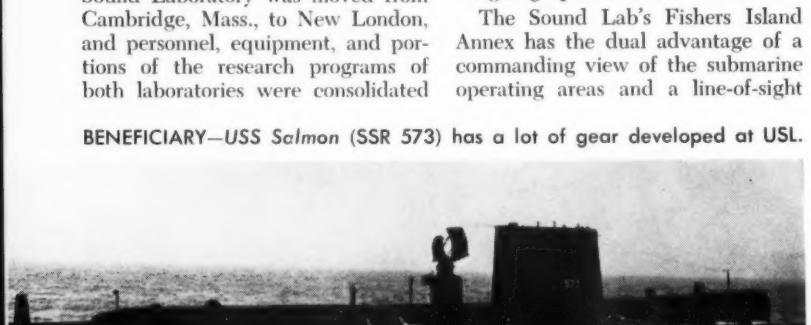
BY MEANS OF bottom-mounted hydrophones located in 120 feet of water about three quarters of a mile to the southeast of Fishers Island, acoustic measurements may be taken and recordings made of over-all sound pressure levels of underwater noise in the area. This hydrophone assembly is mounted on a steel platform with the crystal elements about four feet above the ocean floor. Armored cable connects the assembly to monitoring and recording instruments installed at the Annex. There a log of wind velocity, weather data, sea conditions and ship traffic is maintained for correlation with the noise measurements. Optical ship-tracking instruments in the building provide for accurate determination of a ship's position, speed and course, relative to the underwater hydrophone's position.

There are many other test units at the Fishers Island Annex, including a Radio Test Facility. It has both an underground antenna-testing laboratory and a radio operating center. Here, system-performance tests and efficiency measurements on submarine radio communication systems may be accomplished under conditions closely simulating those found aboard an operating submarine.

In recent years the Underwater Sound Laboratory's extensive research and development program has resulted in a large number of new and improved electronic weapons and techniques. These include new underwater detection systems for use by submarines and surface ships, new capabilities in underwater communications, radically new electronic devices for use in amphibious and underwater demolition team operations, improvements in submarine radio communications, and new applications of infrared energy to tactical and strategic requirements.

More recently, the Laboratory's research and development effort has

BENEFICIARY—*USS Salmon* (SSR 573) has a lot of gear developed at USL.



expanded into the field of continental defense against enemy missile-launching submarines and, at the same time, the field of missile-guidance for our own submarine-launched missiles.

THE NAVY'S OVER-ALL requirements for longer detection ranges for both passive and active sonar systems have had a major influence on USL's current work-load. Research and development on methods of achieving long-range detection has led to the establishment of major projects in the fields of submarine sonar, surface ship sonar, and coastal defense.

The subject of sonar has been discussed in detail on pages 36-41. USL has a major interest in the many projects related to this field. Its submarine sonar program, for example, involves the development of improved bearing tracking, single-ping echo-ranging, passive ranging, sonar communication, and target-designation systems, as well as the investigation and improvement of means of increasing detection range, including new array systems, and the development of various components and equipment.

In exploiting the submarine sonar program, the Underwater Sound Laboratory studies the ASW problem for submarines and studies and develops improvements to existing submarine sonar equipment.

As our submarines improve in versatility and effectiveness, and as the threat of enemy submarines grows more deadly, the importance of the work at USL will also grow. You can be assured that USL's seagoing scientists will continue to exert a great deal of influence in fulfilling the requirements needed for modern underseas and antisubmarine warfare. Understanding these requirements, the USL team will conceive and develop new equipment and thus point the way to more effective ASW tactics.

Almost daily new ASW detection devices are appearing in the Fleet. And they come largely through the dedicated efforts of the Underwater Sound Laboratory and other research facilities. Measuring up to its responsibility, USL will continue to help the U.S. Navy maintain control of the seas and in turn provide the nation with a greater degree of national security.

—H. George Baker, JOC USN

Sound Fleet of USL Carries Floating Labs to Sea

No story on research and development in connection with electronic and underwater sound in relationship to ASW would be complete without giving proper credit to the Underwater Sound Laboratory's afloat facilities.

As said in the accompanying story, the staff of USL consists of seagoing scientists who spend approximately 40,000 man hours per year at sea collecting research data and carrying out shipboard tests of new equipment.

This highly important phase of USL's work is done aboard USS *Maloy* (DE 791), USS *Witek* (DD 848), USS *Somersworth* (PCER 849), USS *Fairview* (PCER 850), and USS *Brattleboro* (PCER 852). These ships are extensively instrumented to provide maximum ease and flexibility in the installation and testing of sonar, radar and infrared equipment. They are assigned to the New London Development Detachment of the Operational Development Force.

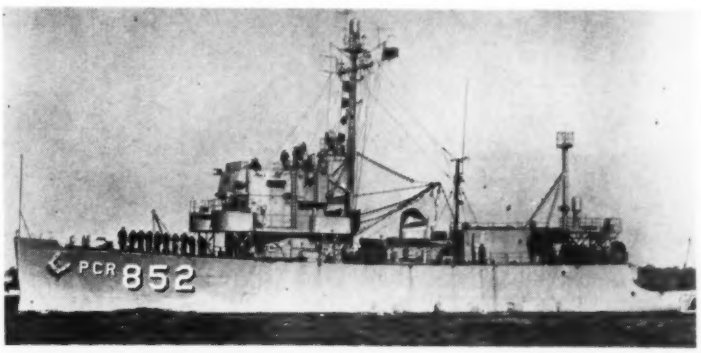
The three PCERs are 180 feet long and have a displacement of 850 tons. They are wartime patrol craft which were converted to "floating laboratories" according to USL specifications. During this conversion, the ships were extensively modified and equipped with all types of instrumentation.

In the conversion of *Somersworth*, for example, a sonar laboratory was built on the main deck, aft, in an area measuring 30 by 34 feet. This area was modified to accommodate equipment, power panels, a work area, and an office. The equipment installed in this area provides the basic information necessary for experimental work and includes a gyro repeater, a dead-reckoning tracer, an underwater pitlog indicator, a radar repeater, wind-direction and intensity-recording equipment and the latest types of fathometers which automatically record depth to 4000 fathoms.

Another major area, 26 feet long, is located in the forward part of the ship. It was modified from the keel to the upper deck to permit installation of hoist units for lowering transducers into the water. This area consists of eight sea chests, which vary in size from 5 to 42 inches in diameter. These sea chests are equipped with a gate valve and an upper sea chest to allow the replacement of transducers while the ship is waterborne.

Topside, there are two handling booms. The forward one is used primarily for loading the sonar antennas into the hold; and the after boom is utilized for towing such objects as noise generators and other vehicles.

An unusual feature in the PCERs is a submarine periscope which was installed to permit personnel working in the shipboard sonar laboratory to make visual observations of targets being tracked by sonar.



SOUND SHIP—USS *Brattleboro* (PCER 852) is one of USL's floating labs.

TRAINING for NAVYMEN

ON A COLD MARCH NIGHT in 1944 USS *Bronstein* (DE 189) went into action against a pack of enemy U-boats. Four hours later this ship had:

- Helped sink an enemy submarine and had severely damaged another . . .
- Survived a crippling near miss from an acoustic torpedo while breaking up an attack on an escort carrier and . . .
- Sunk the third U-boat encountered.

Bronstein wasn't a combat-scarred veteran, wise in the ways of ASW. She had been in operation just seven weeks. Only the captain and the exec, and 10 per cent of the enlisted men had been to sea before. But with her first 3-inch salvo she exploded a shell against the conning tower of an enemy sub making a surface torpedo attack against two other escorts. A continuous fire forced the submarine to submerge after it had launched its torpedoes in a futile attempt to destroy *Bronstein*.

Later, sonar reported another contact and *Bronstein* partially disabled that sub in the first two depth-charge attacks. Joined by two more DEs, *Bronstein* soon sent the U-boat on its last slow glide to the bottom.

Joining up with USS *Block Island* (CVE 21), *Bronstein* detected a sub directly beneath the carrier's hull. Depth charges were dropped by *Bronstein*.

Minutes later a torpedo exploded beneath the escort's hull, knocking out the entire electrical system and causing a loss of engine control. For 15 minutes the DE lay dead in the water while the crew located the trouble and made repairs. With the engines restarted, contact was soon regained and the U-boat destroyed.

WHAT CARRIED THIS CREW—most of them still in their 'teens—through this battle? Whatever it was, a large share of the credit should go to their training. True, the training was brief, but the indoctrination they received made it possible for this green crew in a green ship to play their cards well when the chips were down. The depth charges were handled perfectly, the sonar tuned with precision, the surface fire on target and the lookouts accurate and alert. To prove that their record was not just a fluke, *Bronstein* depth charges cracked the plates on another sub 16 days later, forcing it to the surface where it was sunk by gunfire from the escort and a destroyer.

Training is even more important today. The skipper of the surface ship must know not only how to fight his own ship, but also what to expect from the air and sub-surface units waging the coordinated attack with him. His sonarman must be able to detect targets with a precision unknown in World War II.

Included in present-day ASW planning is one of the Navy's most elaborate school and course systems, training all hands from the rear admiral commanding an ASW task group to the seaman striker assisting in sonar. This ASW training not only includes the electronic wizard but also the gunner, boatswain and, in fact, everybody in the ship.

For the Navy's purpose you might term this education system an ASW "university" which offers intangible degrees in the art of fighting enemy submarines and the proper use of ASW equipment. This university has campuses scattered along both coasts. Six Atlantic Fleet training centers and schools offer 60 ASW/AUW (advanced underwater weapons) courses while four Pacific Fleet Schools offer 52 subjects to ASW students. This curriculum does not include the associated studies in gunnery, radar, CIC and other subjects that can be applied to ASW.

JUST AS IN A civilian university, the nature of the studies dictates the type of "degree" received. Those officers and men enrolled in a basic course, such as the 24-week long sonarman course or the three-week long deck watch officer (ASW) program, are working for their "bachelor" degree.

If awarded, the "master's" degree in ASW would go to those who complete courses such as the one designed for advanced sonarmen or convoy commodore studies. Only those that take subjects such as the tactical commanders course or study the very advanced maintenance for fire control systems are eligible for

SOUND TRAINING—Sonarman trainees at Key West learn job by doing.

ASW

the imaginary "doctor's degree" from the Navy's ASW school system.

Visit any one of the ASW schools and you will find them much like civilian schools of higher education, even though the students are in uniform. One difference you will note, however, is the seriousness that prevails at any of the ASW "university" schools. The students know that a lack of knowledge on their part might cost not only their own lives, but those of their shipmates and possibly many, many, more.

The study programs offered by the 10 Fleet schools vary from one day to several months. In addition to those already mentioned, training is available in the use of airborne sonar, both towed and dipping; various ASW fire control systems; sound range recorder and bathythermograph operation; shipping control indoctrination; submarine sonar; various attack teacher refresher courses; and many, many more.

TYPICAL OF THE SCHOOLS where these courses are offered is the Fleet Sonar School at Key West, Fla., which offers some 41 courses of instruction. They range from the basic sonarman training program, to antisubmarine tactical courses for commanding and executive officers.

The mission of the Fleet Sonar School is "to train personnel in the tactical aspects of surface ship antisubmarine warfare and in the operational and tactical use of all types of sonar and allied equipment and in the manipulation, operational, preventive and technical maintenance of these equipments in order to provide for the most efficient accomplishment of related antisubmarine and submarine warfare tasks."

A walk through the corridors of the school's three ultra-modern buildings will show that all this and more is being done. Open one door and you will hear crisp commands being given in an attack teacher just as if it were really a destroyer engaged in a duel with a submarine. Behind another door, an instructor is describing certain sounds to a group of potential soundmen who will soon be guiding a submarine, surface ship or aircraft toward a submerged target. What was that crackling noise? Just a school of shrimp.

SKATING TO SEA—Navy's third A-sub, *USS Skate*, heads to sea on cruise.

Next door a group of petty officers studying maintenance listen to a veteran sonarman explain an electronic circuit. When they graduate they will know where to look for trouble in the equipment and will know how to care for sonar gear so that it will not fail during an engagement.

INSIDE THE SCHOOL buildings, or training on the locally-based surface and sub-surface ships, is a student body of 900 Navymen, 200 of whom are officers. About 50 "boots" are received each month from recruit training to undergo basic instruction.

A typical officers' class at the school is composed of destroyermen, aviators and submariners. They learn the coordinated tactics necessary in modern ASW. A high-speed, maneuverable submarine might outfox a single ship, aircraft or submarine, but through their combined efforts a net will be woven that will insure the destruction of the enemy.

To bring any of these ASW units into action you first must have a target. Finding the target is the job of the sonarman. Training at the Key West installation and the Sonar School at San Diego is designed to carry the sonarman from the basic course of instruction through to the operation of various sonar-controlled fire control systems. By the time he completes his basic and advanced training he will be a skilled underwater sound technician.

Another vital course offered at Key West is the Underwater Ordnance Locator (UOL) program. Students from the advanced sonarman section study operation or maintenance of the equipment. A third course trains officers in UOL supervision methods.

FLEET SONAR School at Key West Fla. offers 41 courses in ASW from basic sonar training to tactical courses for commanding and executive officers.

Although not directly connected with ASW the UOL course is important in safeguarding channels and harbors that might be mined by an enemy sub. Graduates of the courses are usually found serving with the Mine Forces.

ONCE EACH MONTH, Sonar School students from the commanding/executive officer course go on board ships, subs and planes for a "no holds barred" underway operation. Submarines — positioned several miles away from the formation before to the beginning of the problem—have been instructed to penetrate the screen and "destroy" the simulated carrier (a PC or DE).

Sonarmen listen for the echo that indicates the presence of the submarine, and the attack begins. Practice torpedoes are fired by the subs and plaster-loaded hedgehogs are launched by the destroyer types, which face an enemy capable of deep dives, radical maneuvering, high and low speeds and other evasive measures. Aircraft overhead carry homing torpedoes with practice warheads and training type depth charges.

Students man key stations and actually control the ships' movements. Student officers plan the deployment of the attack units against the aggressor submarines. Enlisted students man the various sonar and associated ASW stations throughout the ship. But, in this case, the hunter is also the hunted, for the subs are invited "to do their worst" including torpedo attacks against the screen.

At the conclusion of the two days of underway training the students will have been subjected to the most common ASW situations. Staff instructors at the school collect the logs and tracks of all participating units and prepare a detailed analysis of each exercise. Mistakes are emphasized at this end-of-course presentation to show their potential combat cost.

SUCH UNDERWAY OPERATIONS cost money, even though they may last for only two days, and they are hard on the ship, its equipment and crew. To achieve nearly the same results as underway training, the Navy has established the Fleet Antisubmarine Warfare Tactical School in Norfolk, Va.

Located in a building near the Destroyer - Submarine Piers, the school gives flag officers a chance to maneuver electronic HUK groups against a pack of enemy subs. Destroyer commanders maneuver their ships according to their orders as they launch an attack, or keep station in the screen protecting a CVS turning to launch. Pilots maneuver fixed wing aircraft in search patterns, while helicopters hover over contacts.

All of these ASW units exist only as points of colored light on a large screen in the school's auditorium, guided by the movement of controls in separate rooms or mock-ups (MUPs). If a course change to starboard is ordered, the new course is set up on the dials in the MUP and the dot of light will advance at the speed set on the speed control dial in the mockup. Standard items of shipboard gear, including radar repeaters and plotting devices, are found in the MUP which serves as the support aircraft carrier, and in the six that represent destroyers. The three MUPs rigged as fixed wing aircraft, and the four as helicopters, carry appropriate gear. One other mockup is used by OTC (officer in tactical command) flag plot.

Using standard radio procedures, the MUPs communicate with one another through an intercom system. Orders are passed and acknowledgment given. Many of the students have observed that it is just like being at sea, but with one thing missing—the roll.

THE INSTRUCTORS at the school are able to provide the nuts and bolts of an ASW problem for the students to solve. These students are then able to work out a solution without the steaming necessary in underway training, a valuable saving when you consider that a week-long exercise at sea for a HUK group will have an accompanying fuel bill running into six figures. However, the students must still think at the same speed and must arrive at decisions without reference to text books.

Students attending the task group course come from units of a HUK group that will soon be operating at sea. They spend the first week in school discussing techniques and tactics of ASW and working out problems on the trainer. The second week of the two - week course is spent at sea where the various ASW battle situations are again worked out, this time with the ship's accompanying roll and under the watchful eyes of the Tactical School instructors who go to sea with the task group.

A group of approximately 34 officers and 50 enlisted men represent the ASW teams of destroyers attached to the task group. Eight officers are sent from the carrier's helicopter squadron while the fixed wing outfit sends over an equal number of officers plus three enlisted men. The HUK group commander and his carrier staff will include a dozen or more officers and 16 enlisted men. This is the only course offered by the school in which enlisted men participate.

Other study programs offered by the school include the command course for skippers and XOs of destroyers, air ASW squadrons and submarines. The operations course indoctrinates junior officers (ensign to lieutenant commander), in ASW procedures. Senior officers (commander to rear admiral) attend the tactical commander's course, while a fifth course is offered for surface and air ASW units. Each of these units sends its ASW team to the school to practice individual tactics.

WHEN A PROBLEM has been worked out to its conclusion, the students leave the MUPs and assemble in the auditorium where the movement of the attacking submarine and each of the ASW units will be outlined on one of two plastic panels. One panel is used for the over-all operations covering a wide area, while the other is used for localized problems occurring very near the task group.

After each "operation," the tactical team will go over it step by step, judging errors, any delay in response and cases of indecisiveness. These sessions are often critical, biting and provocative, but are always illuminating. As one captain said, "It may be a bit embarrassing to see how you've fouled up the problem, but believe me, "I'll take my hits right here, if I can avoid something similar at sea."

Although costly to build, the ASW Tactical Trainer has already repaid the Navy many times over. As the instructors watch, the dots of light indicating two destroyers move toward each other, meet and pass over. A bell rings and the instructor passes the word, "Collision, Collision." The trainer has just paid for itself again.

The key word to the training offered by the tactical school is COORDINATION. One of the cartoons used to press home the importance of team work shows an angry sub scoring hits on two surface ASW units which have neglected to use their assigned aircraft. The plane is saying, "Now dammit, COORDINATE."

Assisting the director of the school are three deputy directors; an aviator for air, a veteran sub officer; and an officer with a thorough knowledge of the destroyer force. Their mission is to give formal training to individuals and ASW units in all phases of coordinated tactics—and—to assist in the evaluation of current coordinated ASW tactics, and the development of new tactics. They recognize that no one unit has complete ASW capabilities and that the units of a HUK group must rely upon one another, have knowledge—and take advantage of —the ability of others.

BASIC AND ADVANCE tactics for surface and air ASW units are also taught by appropriate type commanders. For example, the naval air forces in the Atlantic and Pacific each maintain Fleet Airborne Electronic Training Units which offer ASW courses.

Basic courses at these schools give students an all around introduction to airborne ASW, with equipment, tactics and weapons being covered. Advance courses are also taught.

Destroyer forces make use of attack trainers—usually installed on tenders or at nearby shore bases. These are used to indoctrinate new officers and enlisted members of the ASW team or to provide refresher training for key personnel.

Complementing the elaborate system of shore training provided by the Fleet is the underway training program. These vary from single ship or plane exercises to full scale HUK groups maneuvering off the coast.

As in all forms of education the underway training begins with basic steps and advances into more complex problems. A basic problem would find a sub attempting to penetrate the screen of an ASW task group. This operation would run for just a few hours and cover a small area. An advanced problem might find several submarines attempting to pass from one point to another without being detected. In both cases it is up to the trainees aboard the surface ships and in the aircraft to stop the submarine threat.

Quite often they fail owing to inexperience, but as they gain knowlege the job becomes increasingly harder for the submarine.

Underwater sailors may complain that they are restricted in these operations, giving the surface ships more victories than they should have, but they are overlooking the purpose of the training. These exercises are designed to present a great many different ASW problems to the task group personnel in the shortest possible time. To train personnel in the detection of a sub running on its snorkel, it is sometimes necessary to restrict the underwater craft in order to train in a limited time. However, all restrictions on the submarine might be removed in another exercise and the "battle" will continue until a victor is named.

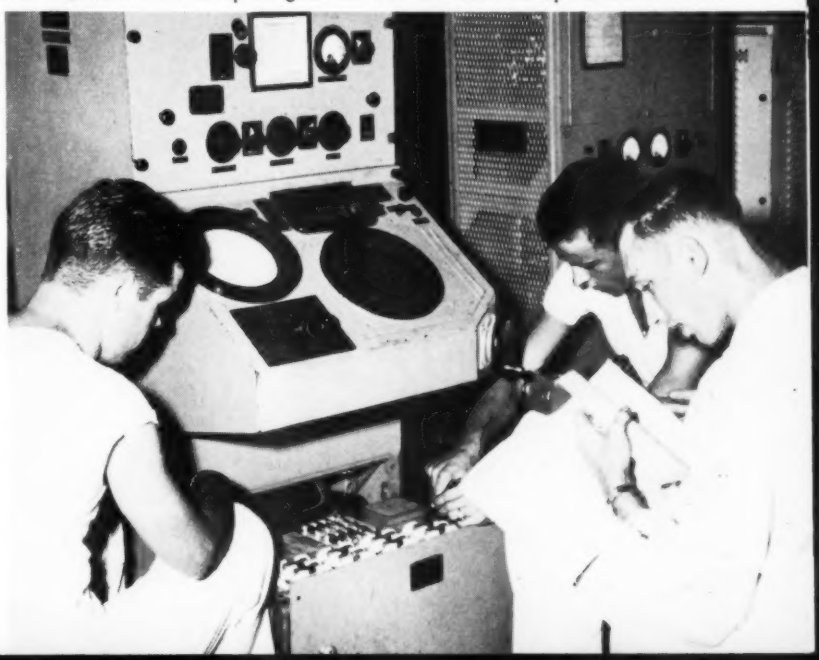
This training results in ASW crews that have encountered in a very short time just about every technique of sub attack and evasion.

Bronstein, mentioned earlier, went into battle with only training on its side and very little experience. A few members of the crew more than likely had attended basic courses in their specialty. The officers had received indoctrination in ASW techniques, and the crew had worked as a unit while undergoing shakedown underway training. The result of this ASW training was a complete victory over the enemy submarine force.

ASW training today is the key to tomorrow's ASW victories.

—William Prosser, JOC, USN

BEHIND THE SCREENS—Students at Navy schools must learn how to repair and maintain their complex gear as well as learn its operation in ASW.



'ALL BACK ONE THIRD'—The team commander and the port and starboard lookout prepare for getting underway on board ResTraSub *USS Peto* (SS 265).

DEEP SUBMERGENCE—Reservists who have been training in a ResTraSub get practical application at the controls when ordered to 'take 'er down.'

Naval Reservists—

They Div-D

"DIVE! DIVE!"

As the command echoes over the submarine's PA system, members of a Naval Reserve attack team spring into action. Manning all diving stations, the Reservists "take 'er down."

For many of the weekend sailors, it is their first sea-going dive on board an operating submarine. For some—Veterans of World War II or Korean conflict patrols—it is old stuff.

The Reservists, primed for their tasks by weeks of intensive training on board a pier-side submarine and at their training center, put the submarine through its maneuvers with skill and efficiency.

This sea-going training is part of the new "U-Drive-It" concept which has been used successfully for more than a year in training submarine Reservists.

More and more of the 27 Naval Reserve submarine divisions scattered throughout the nation are taking advantage of "U-Drive-It" cruises as they make the transition from the old system of one-night-a-week drills to multiple, weekend drills. From the "drive yourself" training they may go on to special Fleet maneuvers and ASW exercises.

Each year, Reservists may make a maximum of four "U-Drive-It" cruises as part of their regular training. They also spend 14 days on active duty for training—usually on board operating submarines. In addition, they have an opportunity to make one or two special cruises, with visits to foreign ports.

Here's how the streamlined submarine training program works.

Naval Reserve submarine divisions are divided into teams—usually from two to six attack teams of approximately 15 men each—and a repair section. Members of the attack teams train so that they will be able to report on board an operating submarine and perform all evolutions in a manner comparable to that of the regular ship's company. In addition to being trained in their individual specialties, the Reservists must have a working knowledge of each piece of electrical and mechanical equipment in the ship. Members of repair sections train for billets on board submarine tenders.

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U-Drive-It Subs

training program, Reservists must first make the team, however—and it's not easy to become a submarine Reservist. Each member of the Silent Service must be a volunteer with a genuine interest in submarines. He must be able to pass a tough physical exam as well as a battery of psychological tests which prove him to be emotionally stable, mature, and a good shipmate. There's no room for a prima donna in the close confines of submarine life.

On his first AcDuTra tour, the Reservist must pass a pressure test usually given in an escape tank or decompression chamber. A high percentage of the prospective submarine Reservists are washed out in this procedure. It's up to the USNR Submarine Program to develop those who qualify into top-notch submariners—ready to augment the ranks of Regular Navymen in the event of a war or national emergency.

Initial training takes place in a Naval Reserve Training Center, where Reservists combine lectures on such subjects as naval discipline and military fundamentals with supervised rate training and team training.

Reservists also get a taste of what submarine life is like on board a stationary Naval Reserve Training Submarine. There are now 23 such submarines functioning as training ships for Reservists, most of which are veteran World War II ships, stripped of their sea-going vitals.

Maneuvering watches are stationed on board these submarines, electrical circuits are "cut in," and mooring lines are handled. Once "underway," the submarine is "rigged for dive." It is estimated that the crew must conduct 225 individual operational and equipment checks when rigging a submarine for dive.

Breeches buoy exercises are also conducted on board the pier-side submarine—Reservists transfer their shipmates from the submarine to the seawall. Other drills include control of flooding, fire, and chlorine gas, and treatment of casualties.

A device known as an "Askania Diving Trainer" is used at some training centers. The trainer is a dry-land submarine, with a full-scale control panel built on a tilting platform. By simulating diving and surfacing operations, it gives Reservists the feel of an actual dive.

The on-the-job training formerly accomplished through attendance at submarine schools or during the annual active duty for training period is now provided at more frequent intervals by "U-Drive-It" cruises.

By the time the Reservists are

SEA DETAIL—Reservists on weekend cruises man steaming watches under regular crew's supervision.

New Selected Reserve Program Adds Strength to ASW Forces

A NEW CONCEPT in Naval Reserve training—the Selected Reserve Forces—will provide added strength to the Fleet's ASW program in the event of mobilization.

The Selected Reserve Forces, as established by the Chief of Naval Operations, are those forces which would be needed immediately at the outbreak of hostilities involving the United States.

Two segments of the Selected Reserve have already been established —the ASW Surface Component and the Selected Air Reserve.

The ASW Surface Component will utilize ASW ships—DDs and DEs—which previously had been slated for mothballing. These ships will be assigned to the Selected Reserve to be manned by skeleton active duty crews, reinforced by newly-formed "Reserve Crews." Thus the availability of additional ASW forces to back up the Fleet will be assured at a cost far below that required to retain similar forces in the active Fleet, off both coasts.

Reservists in selected coastal areas will be organized into Reserve Crews and assigned to specifically designated ASW Selected Reserve ships. The Reserve Crews will be formed chiefly by reorganizing existing Naval Reserve Fleet Divisions and Surface Divisions.

Under the new concept, recall procedures are being improved so that each Reservist in the program will be issued pre-cut mobilization orders to active duty. All Reservists taking part must be able to report for active duty in a matter of hours, without reliance on public transportation.

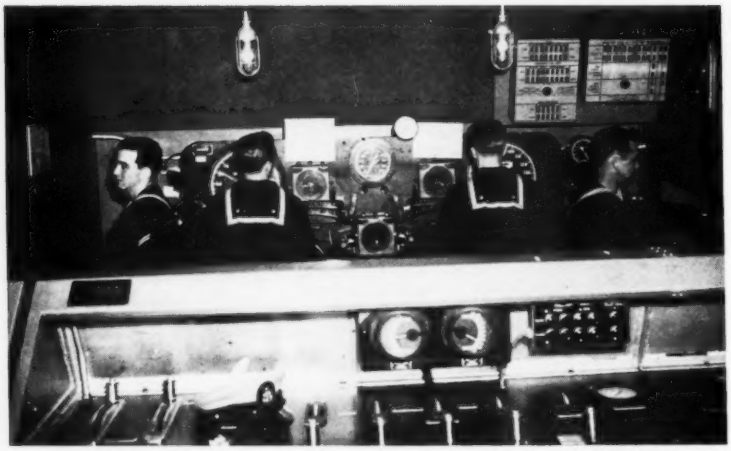
Reservists will perform inactive duty training and annual active duty training (AcDuTra) on board ASW Selected Reserve ships.

Reserve Crews are now being established in Boston, Mass., Fort Schuyler, N. Y., Philadelphia, Pa., Richmond (Yorktown), Va., St. Petersburg-Tampa, Fla., New Orleans, La., San Pedro (Terminal Island) and San Francisco, Calif., and Seattle, Wash. Training in this program is under the supervision of the Commander, Naval Reserve Training Command.

The Selected Air Reserve will not bring about any drastic reorganization of the Air Reserve program. For the most part, present squadron allowances will be maintained. However, the new concept has resulted in a change in emphasis from jet fighter and attack units to ASW units. There will be a gradual decrease in the number of jet units and a corresponding increase of ASW units.

As in the case of the ASW surface component, there will be increased emphasis on the quality and immediate availability of the individual Reservist.

Active duty for training by units will be performed under Fleet commanders. Upon mobilization, Air Reservists in this program would begin operational flights in the same Reserve aircraft, and probably from the same bases used for AcDuTra.



MAKE BELIEVE—The Askania Diving Trainer simulates submerged control operations, complete with honking horns, hissing air and flashing lights.

scheduled for a sea-going cruise, they have a firm grasp of the fundamentals of submarine operations. They report for their weekend cruise already assigned to watch stations for getting the ship underway. Under the watchful eyes of the regular crew, the Reservists quickly turn to.

Once underway, the Reservists take full charge while officers and men of the regular ship's company stand by to answer questions and bear a hand if necessary.

Each Reservist is assigned a maneuvering watch station for all evolutions—getting underway, steaming, surfacing, diving. They serve as auxiliarymen, throttlemen, controllers, line-handlers, lookouts—depending on their qualifications and rate training.

Instead of rotating from station to station, they practice the same job over and over until the mechanics of the operation become virtually second nature. Experience has proved that mastering one job gives the Reservist a better knowledge of why he has to perform each movement connected with the job. In the course of the day, however, almost every Reservist gets a chance to stand at the controls.

Training is not confined to enlisted Reservists. Reserve officers take turns at the conn, as diving officer, and so on. Each attack team has a Reserve officer who functions in the same manner as a regular ship's division officer.

Usually two attack teams cruise at the same time. While one is undergoing practical training through actual operation of the submarine, the other takes part in classroom-type training. The Reservists are divided into small groups, with one of the submarine's regular officers or crewmen taking them through the ship—outlining the functions of the torpedo, engine and battery rooms and explaining the operation of the various instruments.

While on the "U-Drive-It" cruise, Reservists also have an opportunity to qualify for designation as "SG"—qualified for immediate assignment to a submarine—and "SS"—qualified in submarines.

During the classroom period, any Reservist who is ready to qualify for designation is examined by one of the submarine's officers. Each Reservist is given an oral and practical exam to test his knowledge of the ship's compartmentation, air systems, trim and drain systems and the like. The exams are conducted by one of the regularly assigned ship's officers, fully qualified in submarines.

Eight members of Division 8-32, New Orleans, La., who were recommended for "SG" and "SS" designations were put through their paces on a recent cruise on board uss *Medregal* (SS 480). All eight Reservists qualified.

After the Reservists have one or two basic "U-Drive-It" cruises under their belts, part of their training may include attack exercises.

Not long ago members of Divisions 11-6, Los Angeles, and 11-7, San Pedro, Calif., took part in a two-division, two-submarine operation devoted to practice in Anti-Submarine Warfare (ASW).

Early one Saturday morning, half of the Los Angeles division boarded uss *Pomfret* (SS 391) and half of the San Pedro division boarded uss *Caiman* (SS 323). The other members of the divisions underwent the same training the next day.

Approach and attack exercises were conducted each morning, with the submarines alternating as "target ship" and "attack submarine." Several rehearsal runs were made, ending with actual torpedo firings. Early in the exercise Reserve fire control parties scored one near miss and one direct hit—evidence that their preliminary training had not been drawn from textbooks alone. In the afternoon, the Reservists carried out a breeches buoy exercise, executing transfers of personnel while the submarines were underway.

Reservists are also getting the "feel" of the atomic age. Some months ago, a group from the Eleventh Naval District cruised for six hours on board the atomic-powered submarine, uss *Nautilus*, SS(N) 571. The Reservists were briefed on the ship's power plants, hull design and operational capabilities and were taken on a guided tour, with visits to the atomic reactor room and the engineroom. Later in the day, *Nautilus* took part in ASW exercises, giving the Reservists a chance to observe her in operation under simulated combat conditions.

The Submarine Reserve program also includes training in the maintenance and repair of undersea ships and the allowance for each submarine division provides for a repair section. Reservists assigned to this section must be petty officers or officially identified strikers.

Reservists in the repair section would serve in submarine tenders and at submarine bases in event of mobilization. They receive training in submarine construction and equipment and their periods of active duty for training are spent at submarine activities connected with submarine repair, in submarine tenders and with submarine groups of the Fleet.

At the present time, approximately 3000 officers and men are taking part in the ever-expanding Naval Reserve Submarine Program. In the event of a national emergency, they'll be trained and ready to join with Regular Navymen in defense of the nation.

BATTLING THE SUBS-WW II

In the preceding pages of this issue, present and future techniques of antisubmarine warfare have been considered. All this is hypothetical, although we are reasonably sure that, with perhaps minor modifications, our present planning will be effective. We know that ASW does work. The U. S. Navy proved it during World War II. Here's how it was at that time.

The early years of World War II saw the Allies faced with many critical problems but few were more serious than that of the German submarine menace. During 1942, for example, more than 1000 Allied ships carrying some 5,500,000 tons of war supplies and equipment from the United States to Europe were sunk. A daily average of 73 German subs roamed the Atlantic at will. Bathing beaches along the Atlantic coast were closed because of the contamination from the fuel oil of sunken ships. In August, two merchantmen were torpedoed and sunk within sight of the Key West Sound School. During this year, 244 new German subs were built and added to their fleet.

However, the trend began to change in 1943 and, during the following year, enemy submarines began to be harder to find. According to figures issued by Tenth Fleet headquarters: "For each U-boat destroyed in 1941, about 16 Allied vessels went down. For each U-boat destroyed in 1942 the Allies lost about 13 vessels. In 1943, the Allied figure was reduced to two. And by the spring of 1944, a U-boat was going down for almost every Allied vessel sunk."

Technical improvements were important, but one of the major factors in this change were the introduction of the Hunter-Killer force. During 1942, 45 C-3 type vessels, scheduled to become merchant ships, had been converted to aircraft carriers. Of these, 34 were assigned to Great Britain and 11 were retained by the United States. Among these 11 were such well-known names as USS Bogue *(CVE 9),* Card *(CVE 11) and* Block Island *(CVE 21). This is the story of how* Card *and her escort vessels tackled the submarine problem in World War II.*

THE FIRST USN AIRCRAFT carrier to receive a PUC for antisubmarine warfare, *Card* was commissioned in November 1942. She had a standard displacement of 9800 tons, achieved 17.6 knots during her trials, and carried a crew of some 870 enlisted personnel and officers.

In July 1943 she put to sea to engage in antisubmarine operations in Atlantic waters west of the Azores. The task group consisted of the destroyers USS *Barry* (DD 248), *Borie* (DD 215) and *Goff* (DD 247) with *Card* as flagship.

Two days out of Bermuda, *Barry* started proceedings with a sound contact of an enemy U-boat and attacked with depth charges. The submarine escaped, but two

DEPTH CHARGE—One of the best WW II antisub weapons, depth charge had limited range. *Left:* Then, as now, heart of task group was carrier.

days later, two patrol planes found a surfaced sub and, after first attacking with machine-gun fire, sank it with depth bombs.

On the morning of 7 August, another of *Card's* planes, while on routine patrol, spotted two surfaced U-boats running on a parallel course about 100 yards apart. The plane attacked and called for help. In its first attack, it damaged one sub, so it could not submerge, and another was possibly damaged. Within 30 minutes aid arrived in the form of two F4Fs which got a "probable" on the surfaced sub. Shortly after noon of the same day, *Borie* made sound contact with another enemy sub but her depth-charge attack was inconclusive.

For the next few days, all hands continued to more than earn their flight and sea pay. The morning after *Borie's* attack, two patrol planes, with LTJG Sallenger and ENS John F. Sprague as pilots, again spotted two U-boats moving slowly on almost parallel courses. ENS Sprague attacked first with a strafing run on the nearest sub but as LT Sallenger followed, the enemy threw up such intense antiaircraft fire that the electrical system of Sallenger's plane was damaged and he could not release his bombs. Meanwhile, ENS Sprague continued to strafe the other sub in the face of intense antiaircraft fire. When Sallenger went in for his second run, his plane was hit and one of his wings burst into flames. Nevertheless, he managed to release his bombs this time and saw them explode directly under his sub.

ALTHOUGH Sallenger was forced to crash into the sea, he fared better than Sprague. The last that was seen of Sprague, he was going in for another attack and presumably was unable to pull out. Sallenger and one crew member from his plane, James H. O'Hagan, AD3, USNR, were rescued by *Barry* some seven hours later. The others of the two planes' crews were lost. The score: One sub sunk, one damaged. Later that same day *Borie* dropped 16 depth charges on what was described as "an excellent sound contact." Result: "Presumably" destroyed.

The following day, patrol planes found another sub some 65 miles from the task group. It was sunk within a few minutes. One plane attacked with two 500-pound bombs; the second pinned it down with machinegun fire; the third finished the job with depth bombs that cracked the pressure hull. Forty-four survivors were picked up by *Borie*. Others were believed to be in the vicinity, but while picking up these men, *Borie* was forced to dodge five torpedoes, two of them too close for comfort. Under these circumstances, *Borie* decided to leave the remainder to the mercies of the attacking sub.

Things wre relatively dull for the next three days, but on the 11th, one of *Card's* planes found a 500-ton enemy sub and neatly destroyed it by a strafing attack, two depth bombs and a mine.

With the presumed sinking of six subs and damage to two more within two weeks, members of the task force had earned their five-day layover at Casablanca before they shoved off for another ASW operation on 21 August which took them back to Norfolk by 10 September.

Such was the routine followed by the task force. From Norfolk to Bermuda to Casablanca; a few days' liberty while battle damage was repaired and supplies taken aboard. Then back to the milk run which would end again in Norfolk. When another four-stacker, USS DuPont *(DD 152) was added to the group,* Card & Co. *felt ready to tackle anything the enemy could offer.*

ASW DOCTRINE HAD been well established by this time. However, there were still times when you threw the book away if you wanted to get your fish and still survive. In 29-year-old *Borie's* last battle, not only was the book thrown overboard but so was everything else not secured to the deck.

Waves were ranging from 15 to 20 feet during the early evening of 31 October when *Borie* ranged from *Card* to investigate a sonar contact. A string of depth charges was dropped on the sub's estimated location and, damaged and leaking severely, the U-boat obediently rose to the surface, rolled over, and commenced sinking by the stern. Conventional tactics had yielded conven-

TORPEDOES to sheath knives were weapons in bitter ASW Atlantic warfare, but the tin fish worked better. *Right: Helldivers* scratched many enemy subs.

tional results and another German sub went to the bottom.

The next contact, some five hours later, did not follow the book. The sea had grown heavier and, at *Borie's* flank speed of 27 knots, it threw enough black water over the bridge some 30 feet from the surface to smash four of her portholes.

Again, the veteran destroyer laid a methodical, well planned depth-charge pattern and once more a U-boat—the U-405—arose to the surface, but this one did not roll over and sink. *Borie's* searchlight scanned the waters briefly and then came to halt on a huge underseas giant with a prominent conning tower and steel bridge curtain, a wire cutter at the bow and a heavy deck battery.

AS BORIE opened fire with her 4-inch deck guns, *U-405* replied. For nearly an hour the gun battle continued, with the aged destroyer and the pick of the U-boat fleet circling each other in the black, wildly pitching sea. *Borie* received two hits—one amidships and one on the bridge. Gunners of *U-405* were finally driven from their guns by machinegun fire—which was fortunate for them, for a moment later the guns themselves were blasted from the deck of the sub.

USS BUCKLEY (DE 51) was victor in bitter hand-to-hand fight with sub. Only casualty was bruised fist.

Finally LT Charles H. Hutchins, USNR, CO of *Borie,* saw the opening he wanted and drove the old ship directly at the U-boat. There was a crash and a grinding din as *Borie* slammed into the sub's afterdeck and sheared through the pressure hull. Her own bow damaged by the collision, *Borie* rode up over the enemy's stern.

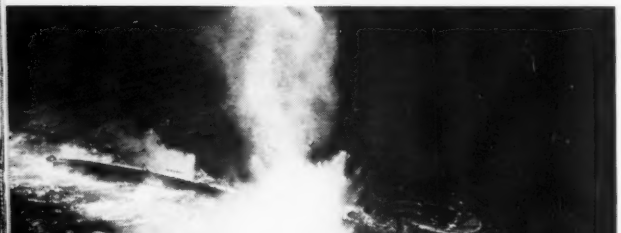
For a long, long 10 minutes the two vessels were locked together while from below the enemy came storming out of their conning tower in a desperate attempt to board *Borie.* Forward, the sub's deck-gunners clung to their mounts and from the U-boat's bridge rifle fire swept *Borie's* bow. Over it all *Borie's* searchlight cast its white glare over the action. At such close quarters, the destroyer was unable to bring its large guns to bear, so they threw — sometimes literally — everything they could into the fight.

Pistols and rifles contributed to the din. A German gunner sprinted down the sub's sloped foredeck and a Yank stopped him with a hurled sheath knife. Hot-shell men flung their empty shell cases. Someone got into the spirit of things and, lacking anything better, heaved a coffee cup at the milling figures. A *Borie* man opened fire with a Very pistol and the U-boat's bridge was lighted with falling stars. Volleys of fire riddled the submarine's conning tower; a burst from a machinegun brought smoke from the structure, and a moment later it broke into flames.

The heavy seas, which had wedged the two vessels together, chose this moment to wash them apart. The U-boat slipped out from under the bow of the destroyer and drifted away. But nearly 30 years of service and the impact against the hull of the sub were too much for *Borie.* Her forward engineroom was taking water rapidly from gaping holes below the water line.

BEAR IN MIND that all this action took place at night with the Atlantic rolling up a sea which would cause concern for the most modern, watertight ship. For *Borie* it was fatal and everyone on board knew it.

It was not long before the forward engineroom was completely flooded; power was lost and her boilers could



DIRECT HIT on German wolf packs was scored by Allied task forces of baby flat tops, destroyers and planes.

get no feed water. Unable to risk a dive, the submarine crawled away on the surface, her skipper doing his best to elude the painfully crippled *Borie*. Once, tracking with radar, Hutchins tried to throw a torpedo attack. Again, in desperation, he tried to close in to ram and missed by a coat of paint. Here, *U-405* responded by attempting to ram the destroyer. The two mortally wounded combatants, each moving slowly because of their wounds and knowing that each must sink sooner or later, threw their final punches at each other—the sub with what remained of his deck guns, the destroyer with shallow-set depth charges. Again, the sub slipped away and again, the destroyer missed with torpedoes.

The end came when *Borie's* gunners finally got on target with their main battery. A salvo hit the burned-out conning tower, reducing it to splintered scrap. The exhausted submariners fired pyrotechnic stars in signal of surrender and took to their rubber boats as the sub went down for the last time.

Borie's problems were not over. The damage control crews and black gang managed to maintain some headway and keep her nose in the waves. Through the remainder of that long, black night she struggled until early the next day when she was spotted by *Card's* searching planes. By afternoon, the entire task group had joined the stricken ship which by now could no longer maintain headway and was wallowing at the mercy of the rough seas.

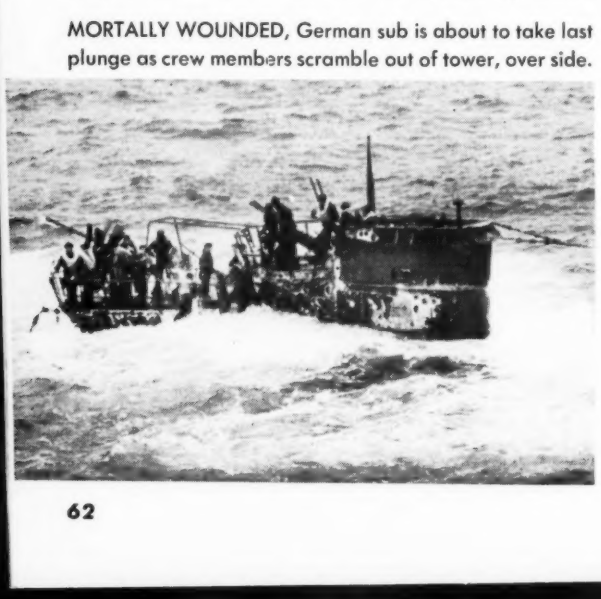
Despite this, a hose was passed to her in an effort to get water into her boilers. However, the water was so contaminated by oil and the waves became so violent that the attempt was abandoned.

That evening, fearful that his ship would capsize overnight, LT Hutchins gave the word to abandon ship. Over the side went her men, with *Goff* and *Barry* standing by in the gathering darkness to pick up survivors. All but 27 were saved.

Although the storm passed during the night, the sea was still heavy the next morning. *Borie* was still afloat, but was down by the stern and wallowing heavily. Salvage appeared impossible, so she was sunk that day by bombs from her own carrier's planes.

Upon her return to Norfolk Card *received a new group of escorts*—USS Decatur *(DD 341),* Babbitt *(DD 128),* Leary *(DD 158) and* Schenck *(DD 159)—as relief for her battered and weary friends but* Card *herself continued her appointed rounds.*

MORTALLY WOUNDED, German sub is about to take last plunge as crew members scramble out of tower, over side.



LIFE WAS GROWING hazardous for hunters as well as hunted and there were times when there was considerable doubt as to who was which. Consider, for example, the long, long night that *Card* found herself within a nest of some 10 to 12 enemy subs when she received word that *Leary* had been torpedoed while attempting to ram a sub. No matter what the odds, one just doesn't leave shipmates to drown, so *Card* spent the night zigzagging and circling at full speed to dodge U-boats while all her escorts but *Decatur* were fishing *Leary's* survivors out of the 46-degree water of the North Atlantic. Finally, about one hour before daylight she was able to launch her planes, and the situation eased considerably.

That morning a young officer reporting to the bridge for his watch found *Card's* red-eyed and unshaven skipper gulping a cup of coffee.

"Good morning, sir," the watch officer said.

"Beautiful morning," the sleepless captain replied, "for a while there I thought we wouldn't see it."

It was 24 Dec — the day before Christmas of 1943.

ALTHOUGH 1944 saw the HUK groups (then known as H/K) making life more and more difficult for enemy submariners, there was still plenty of fight left in Germany's undersea fleet. The men of USS *Buckley* (DE 51) found that out fast when they joined the anti-sub campaign.

The name ship for her class of destroyer escorts, *Buckley* had been commissioned on 30 Apr 1943. After a shakedown cruise to the British West Indies she operated out of Norfolk and later, Miami, Fla., as a training ship, introducing hundreds of Navymen to the Fleet's newest combatant ship—the DE—and giving them a thorough orientation in antisubmarine work.

On 1 Apr 1944 *Buckley* was detached from training ship duty to undertake a series of experiments for BuShips and certain other bureaus of the Navy Department. It was during these tests and trials that her crew got its sea legs in condition for the extended deep-water cruising that lay ahead.

Toward the end of April *Buckley* was attached to a HUK group centered about USS *Block Island* (CVE 21).

Assigned a patrol in the then very active submarine area north and west of the Cape Verde Islands, the group left the United States for South Atlantic waters on 22 April. *Block Island* was destined never to return. (She was sunk by a submarine northwest of the Canary Islands on 29 May.)

By the first week of May the ill-fated escort carrier and her screen were on station. Numerous contacts testified to the presence of enemy submarines in, or passing through, the area, but it wasn't until the small hours of 6 May that a definite target was tracked down. It was *U-66*, already a veteran of some very narrow escapes from destruction.

AT 0216 one of the "night owl" pilots from the carrier reported he had a radar contact on the sub some 20 miles due north of *Buckley*. For about three quarters of an hour the pilot stalked the German, coaching *Buckley* in on the quarry. The sub, apparently waiting a refueling rendezvous, remained on the surface despite a clear night and a brilliant moon just two days short of full.

By 0317 *Buckley* was only two miles from her prey and the U-boat was in plain sight. The DE closed to 2100 yards, then let fly with a salvo from her 3-inch guns which scored a direct hit just forward of the conning tower. Unable to submerge *U-66* took to her heels, turning her stern toward *Buckley*—the better to launch torpedoes.

Buckley, matching the U-boat's every turn, dodged a "fish" that crossed her bow at 0324 and bore on until she and the sub were moving side-by-side with only some 20 yards of water separating them. Meanwhile, other planes from *Block Island* had reached the scene, but were unable to bomb or strafe for fear of hitting the wrong ship. The plane which had originally contacted the sub remained overhead, relaying a play-by-play account to the carrier as the two antagonists blazed away with everything they had.

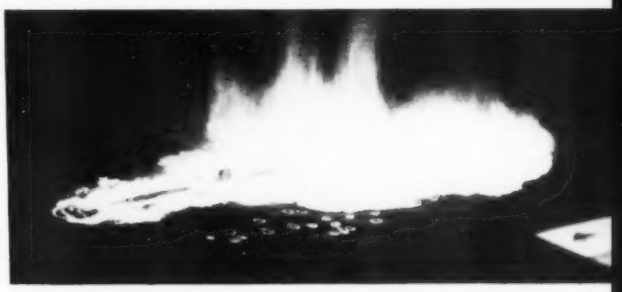
At 0329 *Buckley* turned to ram and rode up onto the submarine just forward of the conning tower. Almost simultaneously the U-boat skipper ordered Abandon Ship. What happened next was a throwback to battles like the one between John Paul Jones' *Bon Homme Richard* and the British *Serapis*.

FROM CONNING TOWER and deck hatches the submariners swarmed out. Some brandished small arms and others had their hands up in token of surrender. Since neither side could understand the language of the other, all was confusion.

Several Germans scrambled up onto *Buckley's* forecastle. The Americans replied with tommyguns, rifles, pistols, shell cases, bare fists and even the coffee cups which were on hand at ready gun station. Two hits were scored with the mess hall crockery.

One would-be boarder was killed with a .45 by the boatswain's mate in charge of the forward ammunition party. The midships repair party, armed with rifles, picked off several men on the sub's deck. A chief fire controlman on the bridge used a tommygun with deadly accuracy. One German even got below, where a steward drove him off with a coffee pot.

After little over a minute of the melee *Buckley* backed off to clear the sub. Five Germans, who were still clustered about the DE's anchor windlass asking for quarter,



FORCED TO SURFACE, sub is target for further attacks by everything that can be fired by planes and destroyers.

were taken in tow by a gunner's mate armed with a hammer.

Evidently *U-66's* engines were still in working order. When the two combatants separated, the Germans who had remained on board were able to run her machinery well enough to pull rapidly ahead of the DE. *Buckley's* skipper rang up flank speed and drew abreast once more. The DE was just about to hit her foe with depth charges from her K-guns when the sub—either out of control or by design—rammed *Buckley's* starboard side, slid under her keel and heeled over so that the men on *Buckley's* deck had a clear view of the U-boat's burning conning tower. One of the Navymen tossed a hand grenade down the hatch into the control room.

Then, the sub scraped clear and made off at high speed again. This time, though, she was out of control and wreathed in flames, her open hatches revealing fierce fires below. The rest of her crew abandoned ship and down she went. The entire action had lasted only 16 minutes from start to finish. *Buckley's* only casualty was one bruised fist.

During the hours that followed, *Buckley* roamed the area, looking for survivors until well after daylight. She recovered 36 men, about half of the sub's total complement.

That afternoon the battered *Buckley,* with a hole in her after engineroom, her starboard propeller shaft sheared and her stem twisted, rejoined her task group, from which she received a rousing welcome. She then transferred her prisoners to *Block Island,* made temporary repairs and steamed off to Boston, Mass.

LAST PLUNGE of German raider marks end of yet one more Atlantic battle between early ASW units and sub.

TAFFRAIL TALK

IN THE CENTRAL THEME that runs through this issue, we've tried to emphasize that the success of antisubmarine warfare depends upon the close cooperation of a vast number of ships, men and units—all working toward a common goal. These, in turn, depend upon the efforts of others, sometimes working thousands of miles from the actual scene of action.

Call it what you will—cooperation, coordination, teamwork—we're simply trying to say ASW, or any other Navy activity, is an all hands evolution. No man ever works alone in this Navy and it's been a long time since any *one* man ever sank a ship singlehandedly.

This somewhat ponderous thought was brought forth recently when, during one of those rare coffee breaks in which the ALL HANDS staff occasionally indulges, we began swapping lies about our experiences in assembling this issue. We discovered, in reality, that without a lot of outside cooperation, we couldn't have done it. Literally, we merely assembled the words and ideas of other Navymen.

For example, there was Alan Pearson, head of the Graphic Arts Section of the Underwater Sound Laboratory, at New London, Conn. He worked with our staff on the centerspread, among other things, and you'll find his signature on that artist's drawing on pages 32-33.

Then there was LT Len Kojm and the staff of SubLant PIO; CAPT R. B. Lynch, ComSubDevGru Two; CDR W. R. Anderson, skipper of USS *Nautilus*, SS(N) 571, who provided George Baker with additional ammunition in his arguments with Destroyerman Tom Wholey and air-minded Bill Prosser—JOCs all.

Along with the crew of *Nautilus*, there was the enthusiastic assistance from the crew of USS *Dogfish* (SS 350), their skipper LCDR Joseph W. Russel; the XO, LT Roy C. Anderson; communications officer LTJG Paul M. Pyper—not to mention Alfred L. Clark, who will always symbolize to some of us not only the crew of *Dogfish*, but any submariner.

From under the sea to over the sea in a ZP-2, we received the word from CDR W. E. Griffin, CO of Airship Squadron Three, and a thorough indoctrination on the unique abilities of blimps from LTA pilots LT Tom Watson and LCDR L. J. Sindell.

Brought down to earth again, we were told about sonar and surface attack by William Sokolovich, SOC of USS *Caperton* (DD 650) and by her skipper, CDR J. B. McCormick.

We were cut in on HUK and CIC by LCDR Theodore Hladick of the staff of ComCarDiv 16, and our path was smoothed by LTJG R. C. Hinshaw, assistant PIO of USS *Valley Forge* (CVS 45).

Captain J. N. Shaffer, Chief of Staff of ComDesLant, gave us a fight talk (but he called it a briefing) on DD types. LCDR R. A. Komorowski, DesLant PIO, helped us along and sent us out to USS *Hugh Purvis* (DD 709). We cruised with *Purvis*, and talked with CDR R. N. Lyberg, the captain, and with most of the crew. The crew obligingly posed for "at work" pix.

Back in Washington, CDR H. G. Bradshaw (somewhat wearily) helped us combine all the information we had accumulated, pointed out the difference between fact and opinion, checked the actual facts, and with CDR W. J. Scott III, helped guard us against security busts. We received the final word from RADM C. E. Weakley and his staff.

We hope you get the point. ALL HANDS comes straight from the Navy. We're just the middlemen.

The United States Navy

Guardian of Our Country

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends. The United States Navy exists to make it so.

We Serve with Honor

Tradition, valor and victory are the Navy's heritage from the past. To these may be added dedication, discipline and vigilance as the watchwords of the present and future. At home or on distant stations, we serve with pride, confident in the respect of our country, our shipmates, and our families. Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

The Future of the Navy

The Navy will always employ new weapons, new techniques and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war. Mobility, surprise, dispersal and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past. Never have our opportunities and our responsibilities been greater.

ALL HANDS the Bureau of Naval Personnel Information Bulletin, with approval of the Bureau of the Budget on 23 June 1955, is published monthly by the Bureau of Naval Personnel for the information and interest of the naval service as a whole. Opinions expressed are not necessarily those of the Navy Department. Reference to regulations, orders and directives is for information only and does not by publication herein constitute authority for action. All original material may be reprinted as desired if proper credit is given ALL HANDS. Original articles of general interest may be forwarded to the Editor.

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• **AT RIGHT: SIGNALS — Destroyermen D. G. Bench, TMSN, USN, and W. L. Thompson, TM3, USN, wait for signal to release depth charge from rack aboard USS *Hugh Purvis* (DD 709) during training off Newport, R. I.**

ON THE RIGHT TRACK

careful calculations
plot the way to
keep vital ocean freeways
open to all